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EXPLODING METALS[1]

B. CLIFFORD HENDRICKS
University of Nebraska, Lincoln, Nebraska

Explosions are usually associated with semi-instantaneous production of huge volumes of gas from either a liquid or solid with an accompanying, fairly large, quantity of heat energy. This double product phenomenon involves a chemical change of the conventional sort. Such changes, for explosive purposes, are induced by detonation and operate on compounds as explosives. Modern explosives of this sort, most usually, are disrupted into simpler decomposition products by the detonation.[2]

Into the framework of the preceding paragraph the idea of an "explosion" by an element just doesn't fit. Until recently the concept of transforming one element into something simpler was not acceptable and such a disruption, even if conjectured, would not be expected to emit heat energy. It would appear, then, that "Exploding Metals" would be assuming the impossible.

Nevertheless the so-called atomic bomb is basically the use of a metal whose nucleus is induced to "explode." It differs fundamentally from bombs of the older design in transferring emphasis from gaseous products to unbelievably large quantities of energy released by the disruption.

SLEUTHING FOR ONE MILLIONTH OF ONE PER CENT

Our story begins with the ambitious program of the Curies in the 1890's when they started out to isolate a radio-active ingredient of

[1] Anecdotes and Other Notes on Metals, SCHOOL SCIENCE AND MATHEMATICS, January 1951.

[2] The explosion of black gun powder, with its carbon and sulfur oxidation, does not fit into this concept of explosion by decomposition.

pitchblende which was ultimately found to be only 0.000001% of the material with which they started. "A needle in a hay stack" is a traditional way of phrasing the impossible to find. In Madame Curie's account, below, is an instance of success in finding a trace that was even less than of "needle in hay stack" proportions. She says,[3] "Certain ores proved radioactive; these were those containing uranium and thorium; but their radioactivity seemed abnormal. . . . It was much greater than . . . I had (expected). I made the hypothesis that the ores of uranium and thorium contain, in small quantity, a substance much more strongly radioactive than either uranium or thorium. . . . This substance must, therefore, be a new element.

"I had a passionate desire to verify this hypothesis as rapidly as possible. Pierre Curie, keenly interested in the question, . . . joined me in the search for this unknown substance.

"We chose, for our work the ore pitchblende, a uranium ore, which in its pure state is about four times more active than the oxide of uranium. Careful analysis of this ore (previously made) led us to expect to find, at a maximum, one per cent of the new substance. The result of our experiment proved . . . the new radioactive element (to be present) in the pitchblende in a proportion . . . (less than) one millionth of one per cent."

The world, of course, knows that they extracted this micro-trace to the satisfaction even of their critics. The publicity attained by their find was, in a large degree, due to the unusual properties of this new metal and its companion, polonium. Polonium and radium were the first of the "exploding metals" to receive public attention. One of the first properties to receive the specific attention of Pierre Curie was the heat evolved by radioactive radium. Thus, even from the first, energy from "exploding metals" was considered noteworthy.

Exploding Metals Prepared in a Shed

Some years later the daughter, Eve Curie, described her mother's part, in the before mentioned search, by saying,[4] "Marya Sklodovska had lived through the most intoxicating moments of her student life in a garret; Marie Curie was to know wonderful joys again in a dilapidated shed. It was a strange sort of beginning over again, in which a sharp subtle happiness twice elected the most miserable setting."

"The shed in the Rue Lhomond (in which the work just described was done) surpassed the most pessimistic expectations of discomfort. In summer . . . it was as stifling as a hothouse. In winter one did

[3] Curie, Marie. *Pierre Curie*, Macmillan Co., pp. 97–8 (1932).
[4] Curie, Eve. *Madame Curie*. Doubleday, Doran Co., pp. 168–70 (1937).

not know whether to wish for rain or frost. . . . If it froze, one froze. . . . The stove . . . was a complete disappointment. . . . No chimney to carry off noxious gases . . . the greater part of (the chemical processing) . . . had to be made in the open air, in the courtyard, (outside the shed.)"

Of this experience, Madame Curie, some years later, wrote,[3] "And yet it was in this miserable old shed that the best and happiest years of our life were spent."

At another time Madame Curie became more specific in her account of those "happiest days of their lives."[5] "We had an especial joy in observing that our products containing concentrated radium were spontaneously luminous. My husband, who had hoped to see them show beautiful colorations, had to agree that this other unhoped-for characteristic gave him even greater satisfaction than that he had aspired to."

Speaking for the year 1900, "We were at this time entirely absorbed in the new field that had opened before us, thanks to the discovery so little expected. . . . We lived in a preoccupation as complete as that of a dream."

"Sometimes we returned in the evening after dinner for another survey of our domain. Our precious products, for which we had no shelter, were arranged on tables and boards; from all sides we could see their slightly luminous silhouettes, and these gleamings which seemed suspended in the darkness, stirred us with ever new emotion and enchantment."

Someone on an occasion remarked of the purity of the lily rooted in the black muck of the water's underneath. Here the glamour of the "luminous silhouettes" in "the most miserable of settings." Perhaps one should sense an appreciation of this emotion-stirring aspect of this metal's "explosion" as well as its threat.

The Pioneer Metal-Explosion Activator

The Curies did not know that it was possible to induce atomic explosions (radioactivity), such as radium exhibited naturally. They did find, however, that other metal, polonium, which, like radium, exhibits natural radioactivity. It remained for the daughter, Irene Curie-Joliot, and her husband to reveal the possibility of inducing non-explosive (non-radioactive) elements to become explosive, i.e., radioactive.

"In 1931 (Irene Joliot and her husband, Frederic) were using polonium as a source of alpha particles by which to shower the element beryllium."[6] "When beryllium was so treated radiations

[5] Curie, Marie. *Pierre Curie*, Macmillan Co., pp. 103–4 (1932).

[6] Hendricks, B. Clifford. *Irene Curie-Joliot Wins a Nobel Prize.* Science Leaflet. 13, 814 (Feb. 1940).

emitted by it showed quite unexpected properties. The radiations continued to be emitted even after the polonium was removed."

Dr. James Chadwick in England was also interested in the use of these alpha rays. Using the same element, beryllium, he put a screen of nitrogen in the way of the expelled radiations from the beryllium metal and photographed the results in a cloud chamber. From a study of these plates he was led to say that the rays from the nitrogen had to be particles, not waves; they had masses of about that of a proton (hydrogen ion) and were without electric charge. Because of this last characteristic they were later named neutrons. For this successful identification of another of nature's smallest building units Dr. Chadwick was awarded the Nobel prize in physics. That was the same year the Joliots received that prize in chemistry for being first to induce artificial atomic-explosions, i.e. radioactivity. Their achievement may be rephrased as "the manufacture of explosive metals by a man-controlled procedure."

It is pretty well known, in recent times, that such production is a rather common-place performance by the aid of the cyclotron. It is noteworthy, however, that both the Joliots and Chadwick used an "exploding metal," polonium, as the source of the disrupting missiles instead of a cyclotron which was not known in their time. So polonium, an "explosive metal," might be dubbed the "pioneer piece of nuclear ordnance."

The Billion Dollar Explosive

As long ago as 1935 Doctor Arthur J. Dempster of the University of Chicago found there were three different sorts of uranium. One of these three was found by Doctor Lise Meitner and Otto Hahn to be capable of neutron-induced fission which in process emits not only unbelievably large quantities of energy but more neutrons which may, in turn, induce fission in still more uranium. Hence, the so-called chain reaction.

The proportion of this "triggery" sort of uranium was found to be, roughly, one part in one hundred and forty of the uranium secured directly from the mines. The idea that an "atomic" bomb could be made was generated by the discovery of this trace-fraction of natural uranium. To find a method of separating this seven tenths of one per cent of the natural metal became the first big problem of the "atomic" bomb project.

The first gleam of success in this job of getting the "needle out of the haystack" is credited to a twenty-seven-year-old physicist at the University of Minnesota, Dr. Alfred O. Nier. He did his work with a sample too minute to be seen with the naked eye.

If his method of separation had to be used, however, it was esti-

mated that "it would take twelve million years to produce a pound of uranium 235. Much more than a pound would be needed for a bomb."[7] A billion dollar project grew out of the international race to isolate enough of uranium 235 to test its explosive properties. It may not be generally known that both General Groves, who headed the assignment for the Army, and Under-Secretary Patterson spent many anxious hours over the uncertainty of its outcome. Under-Secretary Patterson is reported to have become so uneasy about an expense that had passed a billion-dollar mark that he sent out a confidential emissary to learn and form a more objective estimate of outcomes. The report was:[7] "If it works no one will ever investigate its cost; if it doesn't work they'll investigate nothing else."

Triggers for Exploding Metals

To achieve a self-perpetuating reaction of nuclear fission the mass of fissionable material, say uranium 235, must be great enough so that of all the emitted neutrons those caught by other fissionable nuclei must attain above a certain minimum ratio to neutrons not caught. How to determine that mass was the problem facing Dr. Enrico Fermi and his associates as they performed that critical experiment with their pile made of uranium, graphite and cadmium at Chicago on December 2, 1942.

It was Dr. Arthur Compton, director of that Chicago project, who on hearing the news of Fermi's success phoned Dr. James Conant, Office of Scientific Development and Research at Washington. Compton said,[8] "You will be interested to know that the Italian navigator has just landed in a new world. Due to a slight miscalculation, the earth was smaller than he had supposed and he arrived a few weeks earlier than he had expected. He landed on the shore at noon today." Conant answered, "Marvelous! Did he find the natives friendly?" Compton replied, "The natives received him gladly as he had expected. Everyone landed safe and happy."

A Metal that Controls Exploding Metals

The engineer who has to do with power of any kind is always concerned with preventing it from getting out of hand. He provides brakes for speeding cars, and makes provision for "banking" the airplane as it approaches its landing field. Dr. Fermi and his associates were faced with a similar problem as they made ready to test their chain reaction of uranium 235. "Among all the elements, cadmium (is said[9]) to be one of the most voracious for slow moving neutrons.

[7] Stout, Wesley W. *Secret*. Chrysler Corporation, Detroit. Page 18 (1947).
[7] *Ibid*. p. 66.
[8] Darrow, Karl K. *Atomic Energy*, Wiley and Sons. Page 69 (1948).
[9] *Ibid*. page 68.

When neutrons from the pile leaked into one of the three tunnels (containing cadmium rods) the cadmium swallowed them up and that was their finish; (with the neutrons thus imprisoned) the chain reaction never had a chance. The pile was (thus) kept safe by the brake which the cadmium strips provided against the run away. But cadmium strips could be drawn out of the tunnels and . . . if they were . . . pulled out the intensity started to rise slowly, but at an increasing rate and kept on increasing until it was evident that it would actually diverge. Then the cadmium strips were again inserted and the intensity rapidly dropped to an insignificant level." It was after this last withdrawal of the cadmium strips that Dr. Compton put in his telephone call recorded above. He virtually said, "This exploding metal can be made into a bomb." That bomb was tested, July 16, 1945, at Los Alamos, New Mexico.

Metal Child of the Laboratory—It Explodes

Many naturally occurring compounds have been reproduced by laboratory processes. Thus many of nature's products have become manufactured products. Any well informed person readily recalls how indigo, once exclusively obtainable from vegetable plants has in more recent times become quite as exclusively the product of chemical factories. There also comes to mind a train of other artificial synthetics such as artificial rubber, camphor, insulin, etc.

But these are all compound substances. The idea of generating an elementary substance such as a metal is quite another matter. The alchemists dreamed of generating one metal from another by transmutation. Radioactive transformations first alerted scientists to the actualization of that dream. But, in general, those transformations were in the nature of degradations and not build-ups. Exploding uranium 235 produced two fission products of lesser mass than the original starting material.

Events were casting their shadows before, in 1942, when the California cyclotron helped to turn uranium 238 into a triggery metal called plutonium with a mass a number of units greater than that of the mother metal. This accomplishment was also the product of neutron action upon the 238's nucleus. This, it appears, is a sort of build-up rather than a degradation. And, to add further to its novelty, this new metal is, like uranium 235, susceptible to neutron fission, i.e. "explosive." Under test it proved to be capable of participating in a chain reaction quite as devastating as that of uranium 235. It outclassed uranium 235 in that it is, also, naturally radioactive. This metal, unknown otherwhere than by artificial creation, made its star appearance upon the world's stage, flanked with all the trappings of World War II. News headlines, about August 10, 1945, reported

the virtual annihilation of the Japanese city of Nagasaki. This metal-child of the laboratory, plutonium, had gone to war. It is sufficiently potent either as a destroyer or as a source of energy that an entire plant at Hanford, Washington is now assigned to its production. This laboratory-created metal now consumes millions of dollars of tax money in its quantity production. Many tax payers would very much like to know which use is to be its major assignment in the days ahead.

"In the eyes of the chemist . . . (World War I) was essentially a series of explosive reactions resulting in the liberation of nitrogen."[10] An inventory reveals, however, that three other elements, carbon, hydrogen and oxygen, were almost always intimate associates of the nitrogen in producing "the stampede" which was responsible for the movement of the projectile or the disruption of the target. Thus, it appears that explosives of that time were attained by use of compounds of non-metallic elements. Fissionable metals have not displaced those explosives though they have stolen the publicity in more recent times.

Metals of natural radioactivity are not useable for military explosives. Their disruptions are not accelerable to the rates needful for destructive purposes. Since fissionable metals are disrupted by the use of neutron excitation and the neutron density is controllable such metals lend themselves to use for bomb construction. They differ from each other in the magnitude of the energy emitted in the change and so would be rated for use as explosives, in terms of that property. It should be borne in mind that there are other fissionable metals including thorium and protoactinium. These, however, are not yet contenders with uranium 235 and plutonium for their priority as explosives.

[10] Slosson, E. E. Creative Chemistry, The Century Co., Page 14 (1919).

FUR TRAPPER OF THE NORTH

The life of the fur trapper in the northern wilds, his preparations for the annual trapping season and the disposition of the pelts at the end of the season is the subject of a new one reel, full-color educational motion picture FUR TRAPPER OF THE NORTH, released by Encyclopaedia Britannica Films.

The film provides a study of the clothing problem as well as a study of the life and activities of the people who secure furs for our use. It was filmed by Ralph Bryenton, a professional trapper, as he and his partner worked their trap lines.

FUR TRAPPER OF THE NORTH may be purchased from Encyclopaedia Britannica Films, Wilmette, Illinois, for $100 and may be rented or purchased from any of the seven regional libraries in New York; Boston; Birmingham, Michigan; Chicago; Atlanta; Dallas, and Pasadena.

PROFESSOR HOPKINS RETIRES, PROFESSOR OSBORN TAKES OVER

After many years of excellent service to the readers of this journal our editor for Chemical Research is now retiring. Prof. B. S. Hopkins' name first appeared in our list of editors in April 1917. During this period of service he has given our readers a long list of articles contributed by his many associates and acquaintances in the rapidly growing field of chemistry, and has frequently given us the results of his own investigations. His series of articles published just at the close of the Second World War period will ever be remembered by our readers. We wish him a long and pleasant life of retirement among his books and friends.

The new editor is a man not unknown to the members of our chemistry section, Professor Gerald Osborn of Western Michigan College of Education at Kalamazoo, and an officer of the chemistry section now for the third year, this year as chairman. *American Men of Science* lists Mr. Osborn as a native of Indiana, born at Tangier in 1903. Later the family moved to Michigan where he graduated from high school in 1921, received a life certificate at the Michigan State Normal College, Ypsilanti in 1924, the A.B. degree from the same institution in 1927, the M.S. from the University of Michigan in 1929, and the Ph.D. in 1939. He was science teacher and high school principal at Homer, Michigan from 1924 to 1926, instructor in chemistry at the Michigan State Normal College, Ypsilanti, from 1927 to 1929, and assistant professor from 1929 to 1939. After receiving his doctor's degree in 1939 he became professor and head of the chemistry department of Western Michigan College of Education. His excellent work as a student and in research has won him membership in four honor societies, Phi Kappa Phi, Kappa Delta Pi, Phi Lambda Upsilon, and Sigma Xi. His work in the professional societies is well known: a member of the American Chemical Society, one of the organizers of the Kalamazoo Section and later served both as councilor and chairman of the section; a member of the A.A.A.S., Michigan Education Association, N.S.T.A., and C.A.S.M.T. Outside of his regular professional work he is active in church and service clubs. Among his publications are articles in the *Journal of Organic Chemistry*, SCHOOL SCIENCE AND MATHEMATICS, and other educational and professional journals. Mr. Osborn is now at work for you and will be pleased to receive papers for our future issues.

Sell no virtue to purchase wealth, nor liberty to purchase power.—BENJAMIN FRANKLIN

THE NEW FUR INDUSTRY IN LOUISIANA

JULIUS SUMNER MILLER
Dillard University, New Orleans, Louisiana

About a dozen or more years ago the Director of the Fur and Refuge Division of the Louisiana Department of Wild Life and Fisheries received a letter from a friend in Argentina offering to send him a few coypu. This animal, quite unknown in America until this time, is a docile rodent of South America, aquatic in habits, with hind feet webbed like those of a duck. It lives and thrives in marshland, prefers fresh water to salt or brackish, and is entirely vegetarian. It attains a size of 25 to 30 pounds, and has a fur which is either brown and brownish-yellow or bluish-chocolate in color and soft like moleskin. The body is like that of a muskrat, with a long rat-like tail, this often two-thirds as long as the entire body and head. Its mouth is set far back on the snout and, in fact, cannot be seen unless the head is tilted upward. The front feet are like those of a raccoon, and possess a dexterity like the forepaws of a monkey. It is of the Octodont Family, this name being due to the fact that they have four molar teeth on each side of the jaw. They live in pairs in holes in the river banks and feed on water plants, bulbs and roots. The strangest aspect of the animal is the anatomy of the female, which has its teats along her backbone instead of on her belly, this doubtless being a provision of Nature which permits the young to nurse as she swims! They produce a litter about every 8 months with six to ten pups in each litter.

The offer of the animals did not meet with favor for fear that they might, if as prolific here as in their native habitat, lead to a menace to the muskrat fur trapping. The offer, therefore, was turned over to a man whose hobby was "strange animals" and who had a sanctuary on Avery Island. He was elated with the offer and shortly received six pairs. They prospered in their environment and increased their numbers. Some two years later ten or a dozen escaped by trenching out under their wire cages, and thus was born a fur industry of incalculable value—all by accident!

In its homeland, Argentina and Chile, it is known as coypu and the fur is called nutria. Since the latter name is less of a riddle for the listener and much easier on the speaker the animal and its fur go jointly by this title. Accordingly, we speak now of the animal as the nutria and of its fur as nutria too. In South America its fur is a valuable commodity for export.

Happily, the nutria does not encroach upon the muskrat, which until now has been *the* fur crop in Louisiana. Whereas the favorite

muskrat food is the three-cornered grass in the marshes, the nutria feeds on those grasses and grass roots which the muskrats do not eat. They graze on the surface like a cow or sheep and move off to greener pastures when the foraging becomes sparse. There is then, fortunately, plenty of grazing ground in the Louisiana marshland for both the muskrat and the nutria.

They are trapped in the same manner as the muskrats, being caught by the feet in steel traps. The smaller animals are released for the obvious purpose of growing up and begetting its kind. In the 1943–44 trapping season about 400 nutria were taken for fur. In the 1948–49 season nearly 30,000 were skinned.

A mature nutria may attain a weight of 30 pounds whereas a muskrat may reach only to 3 to 5 pounds. Accordingly the fur-pelt is substantially larger than that of a muskrat. Apart from the pelt proper some coarse hairs protrude from the nutria skin, constituting a heavy coat of "guard fur," and these when plucked and chopped produce very fine felt.

The animal is easily domesticated and may be raised in pens if water is provided for its daily habits. Although it does not build a dam as beavers do it does build a "house" like the muskrat.

Thus by pure accident was born an industry which omens well for the trapper and fur trader. The 1948–49 season provided nearly $100,000 in revenue to trappers in Louisiana. Another decade is expected to bring the figure into the millions!

If the balance of Nature is not accidentally tampered with or maliciously hindered by man the case of the nutria is seen to be exactly dipole to that of the rabbit which became, also by accident, such a formidable and invincible pest in Australia and New Zealand.

A NEW BOOK ON PLANT GROWTH SUBSTANCES

Thirty-nine papers by some of the nation's top scientists have been assembled into one volume entitled *Plant Growth Substances,* published by the University of Wisconsin Press.

Edited by Prof. Folke Skoog, noted UW botanist, the volume stems from a UW Centennial symposium in September, 1949, on plant growth substances, and covers the scientific and practical aspects of the field.

The volume is divided into eight sections. It opens with a backgrounding of the field and moves through growth substances in plant metabolism, tissue responses to growth substances, practical applications of growth regulators, growth substances in vegetative development, reproductive development, pathological growth, and vitamins and amino acids as growth factors.

Acetylated cotton ironing board covers and pads are highly resistant to injury from hot flatirons and are claimed to outlast usual canvas covers five or six times. The material is a chemically treated cotton, under a process developed by the U. S. Department of Agriculture.

A STUDY OF WATER FOR GRADES 7 AND 8

FLOYD C. WALKER
McKinley School, Willoughby, Ohio

PLANS FOR MOTIVATING THE STUDY OF WATER

We shall begin our study of water with a field trip to Lake Erie, which is only a few blocks from the school. Probably every one of the children has already seen the lake and is familiar with the narrow strip of not so sandy beach below the cliff. This time we are going with the idea in mind of sharing our experiences and observations. Since the water becomes deep very near the shore line, there may be talk about surf casting or fishing from the small boats owned by many of the residents. Someone will be sure to see the trees at the top of the cliff, roots bared to the wind, for the soil has long since washed into the lake. Someone else will talk of the disappearing shore line, the home at Mentor Headlands which was rescued from the water. Where the sand is hard-packed, we shall look for animal tracks—possibly deer tracks if we are lucky. There will be talk about the plants near the water.

Then a boy will pick up a stone, round edged, for there are no others, and he will ask, "Why don't any of the stones have sharp edges?" Another already knows, "Because the pebbles rub against each other in the water all the time."

A sharp witted girl will ask, "Could these rocks have rolled all the way from Canada"?—and now we are ready to search for information about how water travels around and around.

I. WHAT IS WATER?

A. The three forms of water

Water is one of the most necessary and familiar things in our every day life. We are thankful that it is so common, yet we may have a hard time explaining it until we have studied more about water. This puzzling magic liquid has a mysterious make-up, for it does not always have the same form. We usually think of water as a clear liquid substance but it is not always liquid. It might be solid, in the form we know as ice. Or—presto! a gas which we cannot see.

B. What makes the three forms possible?

Actually, scientists do not think water is magical at all. They know, through their observations and experiments that all of its forms depend upon heat or lack of heat. Even a simple diagram will show how this is possible.

Start with a chunk of ice. Add heat until ice melts. We now have

water. Add more heat until water bubbles and vapor is formed. The result is a gas. Take away heat. It is again water. Take away more heat, much more heat, and we have ice. All this can be accomplished with the same water.

When the ice reaches 32 degrees F. it has reached its melting point. At 212 degrees F. water turns to steam. This is the boiling point. As the temperature drops down below 212 degrees F. the steam is said to condense and water reforms.

The scientist who proves these facts will say that they hold good only at sea level, for the higher up we go, the lower the boiling point of water. How do they know? They make tests to prove things which they suspect might be so, but they never say something is true until it has been proven in the laboratory many times over.

C. Water is a compound

This means that it is made up of two or more elements. Elements are substances which cannot easily be made into simpler substances. Remember we said easily—that does not mean it is impossible to do so. The two substances which when combined, form water are gases known as hydrogen and oxygen. These gases as such take up large amounts of space yet when combined they require much less space.

D. Physical properties of water

The physical properties are those which we can detect with the five senses. If water is pure, it should be odorless, colorless, and tasteless. If it happens to be in large quantities it may have some color, but for practical purposes it can be labeled colorless. It boils at 212 degrees Fahrenheit, and freezes at 32 degrees Fahrenheit.

E. Water is a solvent

Besides these physical properties, there are some other interesting properties of water. When we study how water reacts to other chemicals, we find out what the chemical properties are.

Water is a solvent. This means that water dissolves many things from the air or soil with which it comes in contact, or you yourself might put something into it.

How much of a substance will dissolve or how quickly it will dissolve depends largely on the temperature of the water. Every day at the table you see someone put sugar into hot coffee or tea, and soon it is all melted or dissolved. Stirring or mixing it in usually hastens the process. But it is another story when sugar is added to very cold lemonade. A great deal of it doesn't seem to dissolve at all.

Nature depends on water to dissolve many minerals which are in the soil, to be used as food for plants. Water also takes oxygen out of

the air. Just think how important this process of dissolving is to the carrying on of life.

When nature has dissolved some particular substance or gas so that it stays thoroughly and evenly mixed without separating we have a solution. If no more of this particular substance or gas will dissolve, the water is said to be saturated with it.

F. General kinds of water

Water in its natural state is never pure. We cannot find it in a pure state outside of a laboratory. Why? Because of those powers of absorption which we mentioned above. Water will absorb any substance it encounters which is capable of being dissolved. The amount of the substance which is dissolved in some of the waters of the earth causes us to label the different kinds (most common) like this:

1. Hard water. That which contains certain minerals, which combine with soap and retard the formation of suds. Some of these minerals can be removed by boiling and some can not.

2. Soft water. Water which is relatively free from soap suds-retarding minerals. Rain water is one of the best examples of soft water.

3. Salt water. Usually refers to the oceans or seas in which large amounts of salt (same type as table salt) have been dissolved. Rivers have brought small amounts of salt to the seas over a period of centuries and centuries, and as the water slowly evaporates, the oceans are becoming saltier all the time. The most salty of all is the Red Sea. The only real "salt lake" is our own Great Salt Lake in Utah. The huge salt flat area around the lake shows how much larger the lake used to be, and how much water must have evaporated. We are told that this lake which is not receiving as much water as evaporates every day, will some day dry up.

4. Fresh water. Usually refers to inland lakes and streams which eventually empty into the oceans and mingle with the more salty water of the sea. One does not taste a salty flavor in this so called fresh water, because the amount is so small.

II. The Water Cycle

We can readily see on the globe that three-fourths of the earth's surface is covered with water. There is a large portion of water in the air and in the soil. Water is present in all living things in great quantities. In fact water is everywhere.

Living in Ohio, we have all seen water fall as rain, snow or hail, but how many of us know how water gets into the air in the first place? Surely this is one of nature's greatest wonders, for all of these changes are due to action of natural law.

Have you heard about the men who were trying to make rain in New York State during the past year, when the great city of New York was in danger of a water crisis? The amount of success they had is still open to question because there have not been enough cases to give conclusive proof. Many people are for the idea, yet quite a few are against experimenting with nature. Can you guess why this might be?

Actually nature has a fairly sound plan for her water distribution. Aided by the sun, water passes through all of its forms in a continuous circle which works something like this:

A. Evaporation

Water (or any liquid for that matter) will evaporate when exposed to air and heat. This is true in winter when there doesn't seem to be much heat. Remember there is always some heat in the blanket of atmosphere which surrounds the earth, and this heat is always enough to cause considerable evaporation. This heat, you know comes from the sun.

The boys and girls who have stood on the shores of Lake Erie, have no doubt noticed how much cooler it is there than farther inland. More water from evaporation is in the air, making it damper than the air a mile or so from the lake.

A large part of the earth is covered with water which the sun shines upon and warms. Thus enormous quantities of water are always leaving the surface of the water (evaporating) and mixing with the air. The rivers, lakes, oceans, plants and animals all give off water of evaporation.

B. Condensation

Much of the water that escapes from the surface of the earth and bodies of water becomes cool enough to change back to liquid again. When the vapor cools and becomes liquid the process is called condensation. This causes clouds to form. Great masses of air which are always in motion, move in from the ocean or lake, over the land. They carry the clouds along with them and drop them as rain, snow or sleet on the land.

1. If the raindrops pass through a very cold layer of air they change to sleet.

2. If they pick up more rain and snow as they freeze, they form hail.

3. If the water vapor in a cloud is frozen very quickly the result is tiny snowflake crystals. More crystals form from the first crystals until some get heavy enough to fall.

Now the rain is back to the place where the circle can begin all over again, from the earth up.

III. How Is Water Utilized By Nature?

A. Home for plants and animals

1. Many plants live at the bottom of the lakes and oceans, such as grasses, flower type plants, seaweed, (diatoms) where the water is relatively shallow and still, such as a rocky shore between tide marks. The algae have no roots and only cling to rocks for support. Some great masses of seaweed break loose and float for miles and miles on the surface of the water. One especially famous mass of algae is found in the mid-Atlantic and is known as the Sargasso Sea. It has enough vegetation to impede the progress of ships.

a. Plants feed the animals of the sea such as jellyfish, sea worms, soft mollusks, crabs, turtles. In turn the fish eat these animals.

b. These plants make and throw off oxygen which keeps the water pure. Also they are rich in minerals.

c. Related material—kelp or seaweed is useful to man in making soap and glass, as it is a good source of alkaline soda.

d. Help to prevent wear and tear of coastline in many places. At San Pedro, California, one such mass of tough seaweed forms a natural breakwater which is effective in stopping the long rolling waves.

2. Animal life exists all over most waters of the world. Most life which dwells in salt water cannot exist in fresh water and vice versa. The forms of life range from sponges, polyps, starfish, mollusks, crabs, fish, clams, lobsters, shrimp, oysters, turtles, to mammals such as the whale. What others can we put in the list? Only the mammals have to come to the surface regularly to breathe.

B. Water is essential to all forms of plant and animal life

1. Human body is about two thirds water.

a. Water carries food through the body for distribution.

b. Water carries waste material to organs of disposal.

c. Water dissolves substances in food and reacts with the body chemicals. Helps to renew cells.

2. Plants contain from 10% to 99% water. We should be able to find data to make up a list of our food plants and have some idea of how much water is contained in them. Here are a few to start off the list: tomatoes 94.3%, cabbage 91.5%, and milk only 87.5%.

3. Plants and animals require a continual supply of water in their renewal and growth process. They lose much water also by evaporation.

C. Soil Water

All soil contains more or less water. No soil can produce without water, because the water must carry the food from the soil to the plant, and then on into the plant. Some water remains in the soil, but the rest will not. The water which does not adhere to the soil particles is the kind that causes so much trouble, for it will be that which stays above the ground and keeps the air from entering. Soil must have air for growth of bacteria.

In order to remove this water from the top of the ground farmers cultivate the soil, since it always becomes hard on top with the alternate wetting and sun-baking it receives. Then the water soaks in and mingles with soil particles.

Can you imagine how one medium sized oak tree uses 180 gallons of water a day? Or would you like to water an acre of cabbage plants all summer? Scientists estimate this job would require 500,000 gallons of water.

D. Effects of freezing and thawing

Water has changed our rocks into soil by decomposition and disintegration. The force of freezing and thawing is continually splitting larger rocks into smaller ones. Evidence can be seen in an open stone quarry, of the breaking down process. Action of glaciers is responsible for some of the disintegration.

Suggested Activities

A. Visits

1. To the mouth of the Chagrin River, to get a better concept of the forces that are changing the earth. Water and erosion. Possibilities of its control. Suggested are the following:

a. Ask child to tell points of interest.

b. Arouse interest in the past and future with regard to rivers.

c. Begin to assemble information about depth, width, course, speed of flow, type material eroded. What changes in the valley since their parents came there?

d. Kinds of vegetation.

e. See if there are any indications of whether the valley was formed since the glacier. Students try to find how important water was in development.

2. Willoughby Water Works.

a. A glimpse of how man harnesses water for his own use.

3. To the lake front—used as a motivating force, might even return at the end of water study to see what we have overlooked the first time. Discovery in light of new knowledge.

B. Group projects

1. Miniature model of Lake Erie, showing rivers that feed lake, animal and plant life in and around the lake. Locate lake ports. Locate industry, esp. in our own locality. Importance of fishing along our shores.

2. Stock aquarium. Let the children use own ideas, being careful not to overstock, or there will be insufficient oxygen. Fine chance to study balance of life in relation to water cycle. Will provide opportunity for an unlimited amount of spontaneous undirected observation and enjoyment.

3. Drawing suggestions. (Group and individual)

a. Group work on water cycle map.
b. Watersheds of U. S.
c. Physical properties map.
d. Forms of water.
e. Kinds of thermometers, showing fixed points.

4. Discovery problems for note book experiments

a. Change water from liquid to gas or solid, and draw conclusions.
b. Is water essential for life? Prove.
c. Find boiling point of water.
d. Do liquids contract or expand when cold?
e. Break down water by electrolysis into parts.
f. Find out what water contains.
g. Determine if sample is chemically pure.
h. Make rain with dry ice in air tight box.
i. Make hard water soft.
j. Make soft water hard.
k. Make soap.
l. How does water evaporate? Prove.

5. Globe work

Trace world's waterways. Find course of gulf currents and Japanese current.

6. Dramatizations. Find poetry about lakes or rivers to read in class.

7. Collection of rocks which show influence of water.

Bibliography for Students

The Picture Book of Rivers, by Allan McNab. Macmillan and Co., N. Y. 1932.
The Mysterious Sea, Fred C. Lane. Doubleday Co., N. Y.
The Book of the Ocean, Ingersoll. The Century Co.
The Earth and Its Resources. McGraw-Hill. 1943.
The Gulf Stream, Ruth Brindze. Vanguard Press, N. Y. 1945.
Between Earth and Sky, Marion Gill McNeil. Oxford U. Press, N. Y., 1944.
Water Gardens and Goldfish, Robert Sawyer. A. T. De La Mere, Inc. 1928.
The Book of Water Gardening, Peter Bissett. A. T. De La Mere. 1924.

Ocean in the Sky, Vera Egelstadt. American Press and Ryerson Press, Canada. 1946.
Arcturus Adventure, William Beebe. G. P. Putnam & Son Press. 1926.
In Nature's School, Lillian Gask. Thomas Crowell, N. Y. 1929.
The Book of Fishes. 1924. The National Geographic Soc., Washington, D. C.
The World's Greatest Lakes, Lane. Doubleday and Co., Inc., Garden City, N. Y. 1948.
Blue Angels and Whales, Gibbings. Dutton and Co., Inc., N. Y. 1946.
Among the Pond People, Clara Pierson. E. P. Dutton Co.

Bibliography for Teachers

The Earth and its Resources, Vernon C. Finch. McGraw-Hill Book Co., N. Y. 1943.
Water in Nature, by W. Coles Finch and Ellison Hawkes. London T. C. and E. C. L. T. D. Edinburgh.
The Story of the Great Lakes, Walter Haveghursts. Macmillan Co., N. Y. 1942.
Our Environment and Its Relation to Us, Carpenter and Wood. Allyn Bacon Co. 1948.
Experiences in Physics, Lester Williard. Ginn and Co. 1939.
Exploring the World of Science, Lake, Harley, Welton. Silver-Burdett Co. 1939.
Science for Today, Otis T. Caldwell. Ginn and Co. 1948.
Consumer Science, Hausrath. Macmillan Co. 1940.

Curriculum Material

1. Chamber of Commerce. Cleveland, Ohio. Material on shipping and development of Lake Erie.
2. City Savings and Loan Co. Painesville, Ohio. Large pictorial map of Lake Co. in color.
3. U. S. Dept. of Agriculture, Forest Service, Washington 25, D. C. Pamphlet on natural resources of water and ways to control.
4. Ohio Development and Publicity Committee, Col., Ohio. Map of Ohio's Scenic wonderland.
5. U. S. Dept. of Agriculture, Forest Service, Washington 25, D. C. *What We Get from Trees*. Charts illustrating wood products.
6. *Geologic Atlas of the U.S.* Niagara Folio.

PENNSYLVANIA WATER FILMS

With the threat of water pollution becoming a major cause for concern in post-war Pennsylvania, the Commonwealth's Sanitary Water Board has prepared a double-barrelled film program to carry the story directly to the general public.

Two motion pictures are being distributed simultaneously—"Dangerous Waters," a 35 mm. Ansco Color version for the theaters, and "Waters of the Commonwealth," a 16 mm. Kodachrome Commercial for schools, churches, clubs and similar groups. The theatrical film is a ten-minute one-reeler and the non-theatrical runs 25 minutes, including as it does, more complete coverage and technical data on each phase of the subject.

The productions, from The JAM HANDY Organization studios, involved both studio sets and extensive filming on location. Two cameras were used—one shooting 35 mm. and one 16 mm.—for each scene. Both films are narrated and scored with appropriate musical backgrounds.

Batteryless flashlight throws a bright, wide-angle light produced from a dynamo by a hand-operated lever. This device, made in Holland, has an unbreakable lens, is pocket-size, and comes in a strong polished aluminum case.

NOTE ON THE SUMS OF POWERS OF THE NATURAL NUMBERS

R. F. GRAESSER
University of Arizona, Tucson, Arizona

As an interesting application of the binomial theorem, consider the expansion $(x+1)^2=x^2+2x+1$ evaluated for $x=1, 2, 3, \cdots, n$ and the resulting equalities added member by member. When identical numbers are cancelled from each of the two sums, we have the following:

$$\begin{aligned}
2^2 &= 1^2 + 2\cdot 1 + 1\\
3^2 &= 2^2 + 2\cdot 2 + 1\\
4^2 &= 3^2 + 2\cdot 3 + 1\\
&\cdots\cdots\cdots\\
n^2 &= (n-1)^2+2(n-1)+1\\
(n+1)^2 &= n^2 + 2n + 1\\
\hline
(n+1)^2 &= 1^2 + 2\sum x + n
\end{aligned}$$

Here and in what follows all summations are understood to extend from $x=1$ to $x=n$. Solving the last result for the summation, we have

$$\sum x=\tfrac{1}{2}n(n+1). \tag{1}$$

When the expansion $(x+1)^3\equiv x^3+3x^2+3x+1$ is treated in the same way, there results the equation

$$(n+1)^3=1^3+3\sum x^2+3\sum x+n.$$

If $\sum x$ is replaced by its value in (1), and this equation is solved for $\sum x^2$, we obtain

$$\sum x^2=\tfrac{1}{6}n(n+1)(2n+1).$$

Using the expansion of $(x+1)^4$ in a like manner, yields

$$\sum x^3=\tfrac{1}{4}n^2(n+1)^2.$$

Proceeding to still higher powers of $(x+1)$ gives us the following results:

$$\begin{aligned}
\sum x^4&=\tfrac{1}{30}n(n+1)(2n+1)(3n^2+3n-1),\\
\sum x^5&=\tfrac{1}{12}n^2(n+1)^2(2n^2+2n-1),\\
\sum x^6&=\tfrac{1}{42}n(n+1)(2n+1)(3n^4+6n^3-3n+1).
\end{aligned}$$

The last formula found may be checked by mathematical induction thus verifying it and all of the preceding summation formulas obtained.

ON THE SPOT OR IN THE LIMELIGHT?

DONALD W. LENTZ
President, Central Association of Science and Mathematics Teachers

On the spot or in the limelight? That is the peculiar position of science and mathematics as the Central Association moves ahead into its second half-century. How the powerful forces released by scientific research are utilized determines our future world, and how they are utilized determines whether we shall be on the spot as destroyers or hailed as all-time world champions of progress.

For fifty years the activities of our organization have paralleled the advances—and our leaders and members have been key figures in these advances—in science and mathematics. Now these important fields are highlighted because of the terrific impact of the latest discoveries in the field of nuclear energy on the political and social life of the world. Now, it is more important than ever that teachers of the sciences and mathematics get together to help develop a program for the constructive use of our new tools—a program that includes instilling a human and humane sensitivity in the minds and hearts of young people everywhere.

Let's enter the next fifty years with the good feeling that we can play an important part in determining the direction in which the reasoning of the world goes. Your activity will be vital in setting the tone for the next period in our development. What *we* do as an Association depends upon how well *you* participate in the program and how well *you* utilize the facilities. Our JOURNAL provides many opportunities for you as a reader and as a contributor.

Our annual convention provides a time and place to rub elbows and swap ideas with educators faced with problems similar to yours. Through the exchange of ideas, you gain confidence to carry out projects locally and to extend your ideas into your own communities and among your fellow workers.

The 1951 convention will be held in Cleveland, Ohio. Excellent progress has already been made to insure an outstanding meeting. The local science and mathematics groups are looking forward to our coming, and are planning interesting and entertaining things to supplement the fine professional program which is being planned by our group and section chairmen. Plan to come to Cleveland, for you'll have a wonderful time. We hope through this meeting to maintain the proper perspective by the application of a sense of responsibility and a sense of humor, and to give every member the "shot in the arm" that will stimulate the desire to become an even more effective "teacher of science and mathematics."

SOME NEGLECTED ASPECTS OF SEX

J. Arthur Herrick
Kent State University, Kent, Ohio

It is difficult to imagine an elementary textbook of biology not having a discussion of sex as a method of reproduction. Just as rare is the elementary text that discusses the original function of sex, which, surprising as it may seem, is not primarily a method of reproduction in the usual multiplicative sense, but a protective device which is invoked during periods of unfavorable environment.

Students of morphology generally agree that the flagellates[1] are ancestral to most of the major groups of organisms which comprise both the plant and the animal kingdoms. Since cells of these organisms never engage in sexual union, the chromosome number remains constant from one generation to the next. In the evolution of higher forms the phenomenon of sex has apparently originated independently in each of several major groups (green algae, brown algae, protozoa, myxomycetes, and others). Such parallel evolution in diverging lines of descent is of common occurrence in both plants and animals. Fundamentally, the sexual phenomenon is a process in which two nucleated cells fuse so completely as to form a single uninucleated cell with double the usual number of chromosomes. This process is known as conjugation or fertilization; the cells which fuse are called gametes, and the resulting cell is a zygote. Several variations of this process have arisen.

Origin and Original Function of Sex and the Diploid Condition

In order to understand the basic nature and function of sex, it is necessary to study those lower organisms in which the phenomenon is not complicated by the presence of special structures and secondarily acquired function.

Perhaps the most primitive living forms having sex are the simpler genera of the green algae. Such organisms typically reproduce by the production of flagellated cells called zoospores. These are produced by mitotic divisions of vegetative cells and consequently contain the same number of chromosomes. This chromosome number has arbitrarily been designated as X, N, haploid, or monoploid. Under favorable environmental conditions a zoospore germinates and grows into

[1] The flagellates are characterized by being unicellular, flagellated, nucleated cells. The taxonomic position of these organisms has long been in dispute. Many zoologists give them no special rank but simply scatter them among the Class Flagellata of the Phylum Protozoa; many botanists follow the same pattern by scattering them among the various groups of the algae. From the phylogenetic point of view it does not matter how they are classified since they are the apparent ancestors of both plant and animal kingdoms.

an adult organism. In those species where the mature plant is a single motile cell the zoospore is simply a miniature model having exactly the same structure. If the mature alga is a multicellular plant the spore loses its flagella and through repeated mitotic divisions grows into a mature thallus.

Under certain conditions many species of green algae will produce motile cells which are identical with, or merely smaller than, the typical zoospore. These cells (gametes) are peculiar in that they may fuse in pairs to produce cells (zygotes) having the 2X or diploid number of chromosomes. It is generally accepted that such gametes are really nothing more than slightly modified zoospores. In fact, in some species of algae (e.g., *Ectocarpus*) certain motile cells may germinate as zoospores, or they may function as gametes. The choice of behavior seemingly is dependent upon the immediate environmental conditions.

A basic question which has not been fully answered is: why do zoospores (i.e., gametes) fuse in the first place? In many of the simpler forms the production of zoospores and gametes is accomplished by repeated mitotic divisions of the protoplast of a vegetative cell. If but a few divisions occur the resulting motile cells are zoospores; if the mitoses continue, the resulting cells are smaller and behave as gametes. Why such cells fuse is not known, but it seems that the union of two such cells produces a new cell of greater potentiality. The idea that extra genes increase vitality is not novel. Polyploids (plants with multiples of the original chromosome number) of several species of agricultural plants are characteristically larger and stronger than their diploid ancestors. It has also been suggested that hybrid vigor is due to the concentration of a greater number of dominant genes in one individual. The fusion of these motile gametes is followed immediately by the loss of the flagella and the secretion of a protective wall around the zygote. In this encysted diploid condition the alga is able to withstand prolonged periods of drying, or other adverse conditions, which would be fatal to zoospores and the vegetative phases of the plant. After a period of rest, when the zygote again finds itself under conditions favoring vegetative growth, typical haploid zoospores are produced by a reductional division, thus the diploid or 2X condition is restricted to the single-celled zygote which remains in a dormant condition. Functionally, such zygotes are comparable to the endospores of the bacteria or the hibernating groundhog.

Some authorities suggest that the basic cause of fusion of cells is in some way related to starvation conditions. When plants of primitive species of green algae are in a weakened condition they produce small undernourished zoospore-like gametes which combine their resources

by fusing. It is a widespread theory, based upon much evidence, that the production of gametes occurs under conditions not favorable to vegetative growth and activity.

Another closely related problem, which also remains unsolved, is: why does reductional division occur? It has been suggested that reductional division serves to relieve the instability resulting from an extra set of chromosomes. The evolutionary trend towards a diploid generation, such as the sporophyte of plants or the typical animal body, would then represent an adaptation making this secondarily acquired diploid condition stable and functionally satisfactory. In fact, it appears as though the double set of chromosomes had greater survival value, for in the vascular plants, and in most of the animal kingdom, this is the predominating condition in all life cycles.

The above discussion is based primarily upon the lower algae. Lest we think that the development of sex in the animal kingdom is something different, let us consider some of the sexual phenomena of certain lower animals. The protozoa are one-celled animals, which, like the green algae, the brown algae, the diatoms, and certain other groups, are believed to have evolved from ancient flagellate ancestors. As stated earlier, the phenomenon of sex appears to have originated independently in each of these several evolutionary lines.

In the digestive tract of the wood-eating roach (*Cryptocerus*, a close relative of the termites) there is an extensive symbiotic fauna of flagellated protozoa which feed upon the wood ingested by the insect. As the roach grows it must periodically shed and replace its chitinous exoskeleton. When the time for molting arrives, the animal stops eating and does not again ingest food until a new exoskeleton has been secreted and sufficiently hardened to enable the organism to chew wood. An inevitable result of molting is a considerable period of time when the protozoa must remain alive without any additional food. Some of these protozoa, like certain other evolutionary descendents of flagellates, have contrived to survive the starvation period by the production of diploid cells or zygotes, The gametes are produced by mitosis and are essentially small individuals with the same number of chromosomes as vegetative individuals. These fuse in pairs producing encysted zygotes, which enable the species to survive until food again becomes available. It is also the zygote stage which is able to withstand the rigors of leaving the gut of an adult roach and subsequently being ingested by a newly-hatched protozoa-free insect. This, incidentally, is very essential to the infant roach, since it cannot live without the protozoa to digest its food. When the zygote finds itself in the favorable surroundings of a newly-molted gut or the gut of a newly-hatched roach, it promptly undergoes reductional division resulting in normal haploid trophozoites. These vegetative individ-

uals reproduce by mitosis until another molting crisis arises. The basic nature and function of sex in these one-celled animals is essentially the same as in the low plant forms.

In those primitive fungi known as water molds and their relatives (Oomycetes) the plant is haploid, and the organism's usual means of survival during the winter or other unfavorable seasons is in the form of diploid zygotes. With the return of spring the zygospores or oospores (a zygote with a protective wall) undergo reductional division and germinate by the production of haploid zoospores, which grow into the typical vegetative body or mycelium.

A variation upon this basic pattern is found in certain groups of the algae and fungi. In such organisms as *Spirogrya*, desmids, diatoms, and bread mold, the zygote and the resulting zygospore is formed by the fusion of two morphologically similar vegetative cells. If the organism is unicellular, as in the desmids and diatoms, then a zygote is the result of the fusion of two adult individuals of the species. The zygote promptly secretes a protective wall about itself and remains dormant until conditions are suitable for its germination.

Certain investigators have reported evidence which indicates that some viruses and bacteria also manifest a primitive kind of sexual behavior. This should not be too surprising since sex has originated independently in several plant and animal groups. At present, however, too little is known about such a phenomenon in these organisms to fit them into this discussion.

A consideration of the above facts makes it apparent that the phenomenon of sex has originated in lower forms of both plants and animals as a means of uniting forces for survival during periods of adverse environmental conditions. It is equally obvious that the haploid or X number of chromosomes is the basic or original number and that the diploid or 2X number is a secondarily derived condition.

Evolution of the Life Cycle and Sexual Function

Many cases are known where a structure or a function of a lower group of organisms becomes so greatly modified through evolution that it is hardly recognizable in its most advanced form. As an illustration, consider the transformation of gill arches into jaws or of fins into wings. In vascular plants leaves are modified into stamens, carpels, and other flower parts. The evolutionary changes in sex are no less spectacular. The structural and functional changes in the sexual aspects of organisms vary widely and independently in various lines of evolutionary descent.

In some of the higher types of the green algae (e.g., *Ulva*) we note that the diploid (zygote) condition propagates itself by a series of mitotic divisions thereby giving rise to a plant body having the 2X

chromosome number. Ultimately, through the process of reductional division, such diploid plants, called sporophytes, give rise to typical haploid zoospores. As was explained in the above discussion of the lower algae, the haploid zoospores germinate by growing into haploid plants. Since these haploid plants reproduce by the mitotic production of gametes, they are appropriately known as gametophytes. There is then a distinct alternation of a haploid (gametophyte) generation with a diploid (sporophyte) generation. In higher algae the phenomenon of sex has acquired the function of reproduction in addition to, and in many species, instead of, its protective function. This habit of alternating haploid and diploid generations persists throughout all of the higher plant groups which have evolved from the green algae.

As taught in elementary courses in botany, the sporophyte, or diploid generation, assumes a larger and larger share of the responsibilities of life, until in the angiosperms (flowering plants), the original haploid, or gametophytic generation, has all but disappeared. The microscopic embryo sac, in reality, is nothing but the degenerate female gametophyte, while the pollen grain and its tube is the reduced male gametophyte.

Simultaneously, the zygote has become the most delicate and transitory phase of the life cycle, in contrast to its original resistant, dormant form. We see then that in the flowering plants, as in higher animals, sex is concerned with reproduction alone, in contrast to its original function.

A parallel evolution of sex is evident among the protozoa. Although the minute size of many protozoa makes the determination of chromosome numbers very difficult, sufficient studies have been made to reveal the general evolutionary trends. Like the true flagellates, the primitive protozoan is strictly a haploid organism. Actually there is no sharp line of demarcation between flagellates and the protozoa; many zoologists simply consider the flagellates to be a class of the phylum protozoa. As stated above, there are protozoa whose life cycles are identical with those of the typical green algae. Other species are known in which the life cycle involves repeated mitosis-like divisions of haploid nuclei, alternating with a series of similar divisions of diploid nuclei (e.g., *Sphaeromyxa sabrozesi*, a myxosporidian). This behavior duplicates essentially the life cycle of the higher green algae. Finally, there are species of protozoa in which the active cells (trophozoites) are strictly diploid. Such cells produce haploid gametes by reductional division. The union of gametes promptly restores the diploid condition so that the haploid generation has been eliminated except for the reproductive cells or gametes (e.g., *Monocystis*). This pattern is characteristic of the higher animals. Such a

cycle is one step beyond that which has been attained in the angiosperm line of plant evolution.

A striking difference between the plant and animal kingdoms is that the evolutionary shift from haploid to diploid vegetative organisms has occurred within the Protozoa but is not complete even in flowering plants.

The brown algae are plants which apparently evolved independently from the flagellates. In this line, the evolution of sex and diploidy kept pace with the protozoa. All gradations of life cycles are represented, including the most advanced. Brown algae of the order Fucales are always diploid, except for the haploid gametes. Their life cycle, and the function of sex, is therefore identical with that of the typical higher animal.

SUMMARY

In the various branches of the phylogenetic tree the origin and the evolution of sex and life cycles have followed the same basic pattern. In the lower forms the gametes are alike and very similar or identical to vegetative cells. These change to highly specialized eggs and sperms in the higher organisms. Very primitive species lack sex and are consequently always haploid. The diploid condition is created through sexual union. In primitive forms this diploid stage is restricted to the zygote. Through an evolutionary shift the diploid phase gradually replaces the haploid so that in higher organisms the vegetative individuals are always diploid.

In function, sex shifts from a protective device to a purely reproductive function. This is true in several major lines of evolution.

THE CURRICULUM BULLETIN

The *Curriculum Bulletin*, a project of the School of Education of the University of Oregon, is once again being published and is available on a subscription basis at $5 per year (approximately 24 issues), or individual issues may be purchased separately. Each issue treats a separate topic—units, bibliographies, study guides, background and resource data on newer methods and curriculums, proposals for new curriculums, etc.

The following bulletins will be of special interest to teachers of science:

57—Bibliography of Lists of Instructional Aids to Learning	50¢
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Address: Curriculum Materials Laboratory, University of Oregon, Eugene Oregon.

INSIDE THE ATOM

VII. THE USES OF RADIOACTIVE ISOTOPES

BARBARA R. BALZER
Fieldston Lower School, 3901 Greystone Ave., New York 63, N. Y.

The Chief of Supply for the Atomic Energy Commission at Oak Ridge, Tennessee, is reading his morning mail. His job, in representing the Atomic Energy Commission, is to read orders for radioactive isotopes and to decide which orders for radioactive materials can be granted. In this morning's mail he has an order for radioactive sodium from the medical research laboratory of the University of Minnesota, a letter from a Cleveland manufacturer inquiring whether supplies of plutonium 238 are yet available for commercial use, an order for radioactive carbon 14 from the Department of Organic Chemistry at Brookhaven National Laboratory in New York State, an order for chromium 51 from the Department of Mechanical Engineering at the Massachusetts Institute of Technology, and an order from the University of California Medical School for radioactive iodine.

Not one of these orders is for material that will be used to build atomic bombs. Instead, the radioactive material is being sent out to be used in ways that will help to make human lives more comfortable. The job of the Chief of Supply is to grant permission for amounts of radioactive isotopes to be sent all over the United States.

If we were to follow a container addressed to a laboratory for plant research in Wisconsin, we would discover that it contains radioactive carbon 14 and radioactive phosphorus. These radioactive elements are used as "tracers" in research experiments with plants. The radioactive carbon can be combined with ordinary oxygen to form carbon dioxide. Carbon dioxide is one of the raw materials used by green plants to manufacture their own food. From the sugars and starches made by green plants come all the food and fuel used by man. If scientists were able to discover exactly how the green plant goes about making its own food from carbon dioxide and water in the presence of sunlight, the human race would not have to worry about its supply of food. But, so far, the secret has remained a deep, dark one. Scientists have not been able to discover what complicated process the water and the carbon dioxide undergo to become sugar and starch or even where, in the plant, the parts of the process take place. This is where the radioactive carbon comes in.

The scientists in this laboratory make carbon dioxide from the radioactive carbon and feed it to plants for certain lengths of time. They then stop the food-making process, after different lengths of time, by killing the plant. By using radioactive carbon to make the

carbon dioxide, the scientist has given each tiny piece of carbon dioxide a radio transmitter, for the rays given off by the radioactive bits of carbon can shoot through the plant tissues to the outside of the plant as a signal that a certain amount of carbon is located in a certain spot in the plant's leaves, stem, or roots. A very sensitive instrument, called a Geiger Counter, is held near various parts of the plant. The instrument has a small window through which may come alpha, beta, or gamma rays, or all three, depending upon the kind of screen placed in front of the window. The instrument can be made so delicate that a single alpha or beta particle entering the window will cause electricity to flow between two points inside the instrument. This flow of electricity will cause the counter to click. If many particles enter the window, it will click many times. An automatic electrical instrument counts, and can be made to record, the number of clicks.

When this instrument is held near the stem of a plant which has been killed, say, two hours after it had been fed the radiocative carbon dioxide, the scientists can find out how much of the particular carbon that was fed the plant had reached the stem of the plant in two hours. If sets of curves are plotted showing the measured radioactivity in the stem after one, two, three, and four hours, and the same kinds of curves are plotted for various parts of the leaves and the roots, it is possible to draw a map of the path of the carbon as it flows into the plant in the form of carbon dioxide and becomes part of different compounds on its way to becoming sugar. This map may sometime be very important in unlocking the secret of food-making in the plant.

At the same laboratory, radioactive phosphorus is fed to tomato plants with nearly-ripe tomatoes on them. The tomato plants, at various stages of ripening, are placed on photographic plates. The places in the plant which contain the most phosphorus show up on the photograph as light spots. These photographs are called *radioautographs*, and are a way of measuring radioactivity less accurately than a Geiger Counter. Scientists have found, by comparing radioautographs, that parts of the fruit of the ripening tomato contain large amounts of phosphorus, but that when the tomato is completely ripe, the phosphorus disappears from it. This tells them an important fact about one element needed in the ripening of tomatoes. Scientists in another botanical laboratory are doing the same kind of research with radioactive sulphur, observing in radioautographs in what parts of the seeds of ripening fruit it is found.

If we should happen to follow the parcel addressed to the Massachusetts Institute of Technology, we would discover that it contains supplies of three radioactive metals—copper 64, zinc 63, and chro-

mium 51. Some of the scientists in the Department of Mechanical Engineering are studying how molecules of one piece of metal are able to move into another piece of a different kind of metal when the two pieces of metal are rubbed together over a long period of time. Before radioisotopes were available, they found this a very difficult task to accomplish, even with a powerful microscope, because the molecules move from one metal to another at such a slow rate of speed and are so hard to tell apart. Now it is simple for them to make one of the two pieces of metal with a radioactive isotope of the metal. It is very easy for them to tell, by radioautographs or by Geiger Counters, the rate at which molecules move from one metal to another.

At the University of Pennsylvania, radioactive isotopes of iron are being used to find better methods of making steel. Even melted metals can show off the radioactive properties given to them if they have been made with radioactive isotopes. Before radioactive isotopes were used, no one was quite sure exactly what reactions took place in the making of steel. Being able to find out more accurately those reactions is the first step towards making better steel.

The medical research laboratory of the University of Minnesota requested radioactive sodium from the Atomic Energy Commission. This radioactive isotope is being used directly on badly burned patients in the university hospital. Patients with severe burns often show the symptoms of shock—cold hands, perspiration, chill, pale face, and fast, weak pulse. It is dangerous to leave a patient in this state in order to do research on the causes of shock. It was discovered, however, by injecting compounds containing radioactive sodium into a patient suffering from shock, that sodium, which is usually distributed all over the human body, left all parts of the body except the burned part. To determine this, it was necessary only to hold a Geiger Counter over the various parts of the body to count the radiations coming off. This was no discomfort to the burn patient and gave the doctors valuable clues about the possible causes and treatments of shock.

Radioactive potassium compounds, injected into the bloodstream, are being used in the same way to determine the speed at which blood flows through different parts of the body. Since sodium and potassium compounds both appear in the blood, both of them are useful in determining where certain compounts of the blood go in particular illnesses.

Radioactive iodine has been found useful in many different ways in medical research. Any iodine taken into the body goes eventually to the thyroid gland. Some people who have goiter must have their thyroid glands removed. Once in a while the operation is not successful in getting at all pieces of the gland. Then radioactive iodine fed to

the patient helps doctors to locate the pieces of the gland left in the patients' bodies. Research scientists have been interested, for a long time, in finding out such things as when the thyroid gland in an unborn baby begins working, and where iodine is used in the bodies of animals that have no thyroid. Radioactive iodine has aided scientists to find answers to both these questions.

Doctors in research at the University of Minnesota discovered an even more important use of radioactive iodine. They found that a dye made of fluorescein and iodine 131 injected into the bodies of people with brain tumors would appear in the diseased brain tissues in much greater amounts than in normal tissues. Radioautographs taken from several different angles would help the doctors to know where to operate on the tumor.

For many years, research scientists had thought that the process of growth took place through the building up of body tissues from food eaten. Just recently it was discovered that body tissues break up almost as fast as they are built. Scientists then wondered whether growth was a slowing up of the breaking-down process, or a speeding of the building-up process. They were unable to find out until they learned to make carbohydrates, fats, and proteins containing small amounts of radioactive carbon 14. By feeding these radioactive foods, they were able to find out exactly how long a particular piece of food stayed in the body. When they complete their research, we will know what the process of growth ***really*** is.

The use of radioactive "tracers" to determine the exact path of particular elements through living tissue is considered so important that Professor George Hevesy was awarded the Nobel Prize in 1943 for perfecting methods for using "tracers." The newest development in "tracers" is making "tracers" of "trace" elements—those minerals like copper, cobalt, molybdenum, manganese, and zinc—which are necessary in very small amounts, or "traces," in the human body. The traces of them used by the human body are so small that no one had found a method that could be used to determine where they went in the body. Now that radioactive isotopes of these elements are available, it is easy to discover where they go in the body, even though there are only "traces" of them present.

The representative of the Atomic Energy Commission will have to dictate a letter to the Cleveland manufacturer to tell him that, so far, radioactive isotopes are released only for research and only such research that can have articles written about it published in scientific magazines. So the manufacturer will have to wait for his plutonium 238, but while he is waiting many suggestions and theories for the use of radioactive isotopes in industry will come about. Plutonium 238, for example, would be ideal to get rid of electric charges built

up on moving belts in factories. Any radioactive material placed near the belts will cause the electric charge to leak off gradually and will prevent possible damage from explosion or fire.

It has been suggested that radioactive isotopes dissolved in solutions or in dyes would be good to control the amounts of liquids poured into mixing vats. A Geiger Counter placed outside the vat would automatically shut off the stream of liquid going into the vat when radiation from the vat reached a certain amount.

Radioactive isotopes have been suggested as watchdogs for industry. Hydrogen sulphide and carbon disulphide are used in making rayon. Both can form poisonous gases. But if they were made with radioactive sulphur, a Geiger Counter placed near the tank where they were used would sound an alarm the minute they started escaping. The Geiger Counter could then be used to find the exact place where the gas was leaking out of the tank.

Breakable parts of machinery used in the manufacture of cloth and paper might be made with radioactive material in them. If the parts broke and were carried along with the moving belt of paper or cloth, the machinery could be stopped automatically by means of a Geiger Counter before the paper or cloth went into the hot ironing machine. The metal bits could be located and removed before they ruined large sections of paper or cloth by being ironed into them.

American minds have indeed been busy since the discovery of artificial radioactivity. It has even been suggested that the movements of underground water or oil beds or the movements of masses of air be studied by making them artificially radioactive. The cost of geological research could be reduced in this way, for before the discovery of artificial radioactivity, costly radium products had to be added to oil beds and underground water to map their sizes and to trace their motions.

And a museum guard would be less nervous if the valuable paintings in his care would be placed in frames painted with radioactive varnish, so that they would sound an alarm if they were carried out the door by anyone not authorized to remove them!

WORKSHOP FOR MATHEMATICS TEACHERS

Indiana University, in cooperation with Purdue University, will hold its Fourth Annual Workshop for Mathematics Teachers on the Bloomington campus beginning Monday, June 25 and closing Saturday, July 7. The Workshop will include opportunity for discussion of your particular problems, a Visual Aids Laboratory where you may try your hand at making things, speakers from industry and business, as well as specialists in the field of mathematics. The program should be available around May 15. Write to Philip Peak, Indiana University, Bloomington, Indiana.

A NEW AID TO TEACHING VALENCE

CHARLES BRAUER
Warrensburg, Missouri

It is often difficult to attain a useful degree of proficiency in valence-formula manipulation without the drill becoming dull and monotonous. Student interest often falls short of adept usage.

Although no one teaching tool will solve the problem, the card game outlined below has possibilities for adding fun and enthusiasm to the drill and practice associated with speed in writing and recognizing formulas.

The deck of cards consists of fifty cards, the same size as ordinary playing cards. In the upper left and lower right corners of each card, is placed the symbol of the element or radical the card represents. There is an equal number of positive and negative valences. The "ous" or "ic" ending is placed after those elements having a variable valence. Each element or radical may appear as often as desired in the same deck. The valences are not marked on the cards. The students must look to the Periodic Chart for the valences of the elements, and must learn the valences of the radicals. The cards bearing symbols of monovalent elements or radicals may be replaced with more difficult valences as the students improve in their ability to write formulas.

The game is played much like Rummy. Seven cards are dealt to each of the four players. The remainder of the deck is placed face down on the table, with one card turned face up. Each player, in turn, draws, plays and discards. As in Rummy, plays are made by forming "books." However, in this game a book consists of two or more cards whose symbols make a compound, instead of the traditional "run" or "three of a kind." Thus a player might have a hand containing a card for Na. If he draws a card for Cl, he could play NaCl as a book. The game is ended and the score counted when one player is out of cards. Each card played in a book of two counts one point. Each card played in a book of three or more counts two points. One point is subtracted for each card remaining in the hand at the close of the game. Thus NaCl would be worth only two points, but $FeCl_2$ would be worth six points. It is also advantageous to play compounds containing radicals, like Na_2SO_4, six points. The method of scoring may be readily altered to stimulate practice in any phase of formula writing.

This game has been tested in a practice teaching class in chemistry in the College High School of Central Missouri State College. The pupils regard it as a great aid in learning valence.

BONE PETRIFICATION EXCEEDS DECOMPOSITION IN TROPICAL PANAMA

KENNETH W. VINTON
Canal Zone Junior College, Balboa, Canal Zone

From the shell mounds on the sites of ancient Indian settlements, the instructor and members of the field geology class have dug perfectly preserved bones of deer, turtles, fish, birds and small animals.

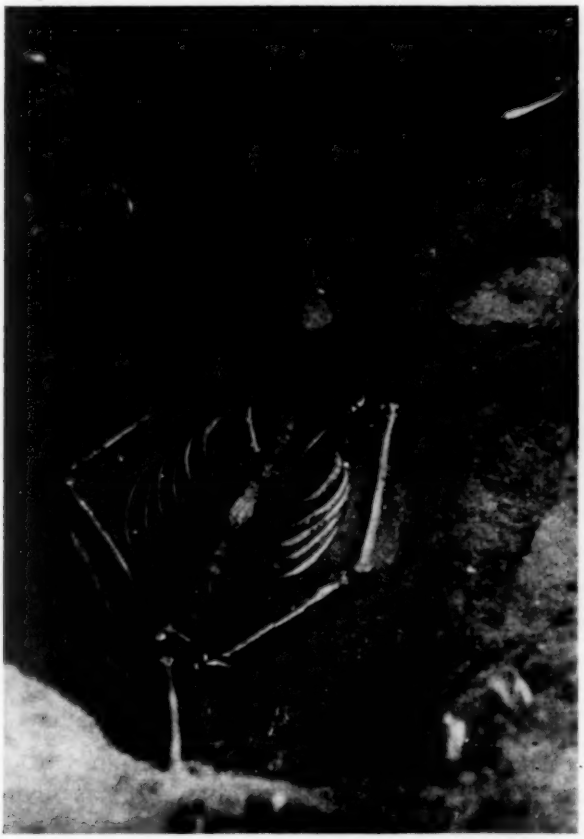

FIG. 1. Five hundred years ago this Indian chief was laid out full length for burial in the yellow sand near the seashore. Lime-bearing solutions, produced by the contact of seashells and humus above, prevented his bones from crumbling, and even penetrated the porous ones, raising the calcium carbonate content to twice the usual concentrations for a normal bone.

The fragile bird bones, fish vertebra, and other small bones were so well preserved in every detail that we could scarcely believe that they were old. Yet the mounds from which they were excavated were estimated to be over five hundred years of age. We knew that

bones were found in shell mounds in the temperate zone but when the difference in the speed of chemical reactions under the influence of the abundant moisture and high temperature of our tropical environment was considered, we could not overcome the feeling that nature was presenting us with false evidence.

Bones may contain as much as eighty per cent of insoluble mineral matter of which calcium carbonate seldom exceeds ten per cent and most of the remainder is calcium phosphate. The remaining twenty per cent includes the organic cell structure that holds the insoluble matter together.

We reasoned that the seashells must react with the organic acids,

FIG. 2. Decorated pottery, cut and drilled seashell ornaments and cut sections of fragile bird bones are all preserved for archaeological study by the action of lime-bearing solutions.

especially carbonic, more readily than the calcium carbonate of the bones, thus preventing them from crumbling. It was obvious that the organic constituents of the bone would decay very quickly under these conditions and we wondered how much of its calcium carbonate a bone could lose before crumbling.

A short time later, the question of bone preservation was revived when a bulldozer accidentally uncovered an old Indian burial site on a nearby army post. No bones are found in most of Panama's Indian tombs, so the archaeologists are forced to estimate the position of the Indian's body by the arrangement of the pottery, the stone tools, and the ornaments around it. This site was quite different, for perfectly preserved bones and whole skeletons were found in

abundance. The graves had originally been cut down through about three feet of black humus, which contained many whole seashells, and penetrated about three feet into a coarse layer of yellow shell-bearing sand. Patches of sand were adhering to the bones, pottery and other objects in the grave and subsequent tests showed that the stucco finish was produced with calcite cement. In this location the seashells in the upper layers had reacted with the decomposing humus and produced so much calcium bicarbonate that the process had begun to reverse itself as soon as the solutions had reached the sand. We were curious to know how much of their original calcium carbonate these well preserved bones had retained.

FIG. 3. This well preserved bone belonged to a toxodon, which was a type of ancient rhinoceras that roamed South America. The toxodons flourished while isolated in South America but when the two continents were joined by a Panama land bridge, a million or so years ago, they were exterminated by the more vigorous animals that invaded their land from the North.

At that time, we had on hand a number of fragments of a toxodon's rib and chemical tests indicated that calcium carbonate was also responsible for its preservation. Dr. Gazen and Dr. White, paleontologists from the Smithsonian Institution, had just returned to Washington, D. C., after excavating the toxodon and several giant ground sloths, and they had estimated the age of these bones to be about two hundred thousand years.

The degree of petrification necessary to preserve a bone in a tropical climate seems to be in doubt. The minimum calcium carbonate content necessary to prevent a bone from crumbling after it begins to lose its original lime is apparently unknown. The question whether the original calcium carbonate content remains in the same physical state, as the bone ages, or recrystallizes as a cementing agent, still

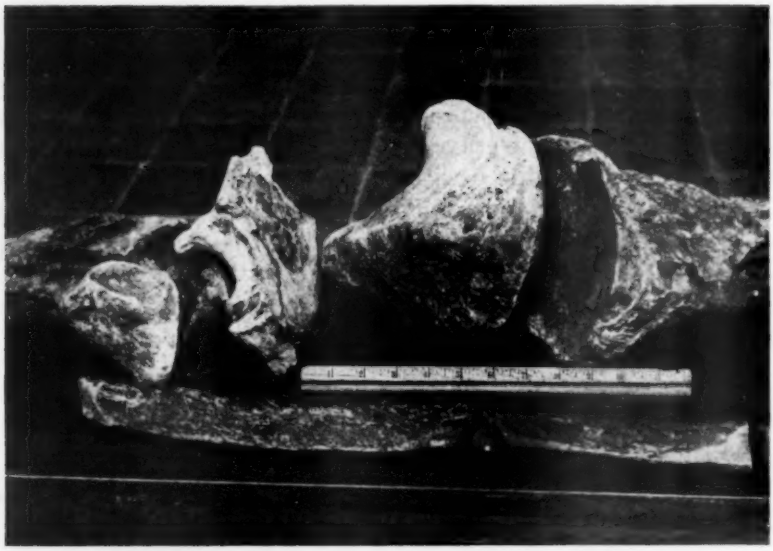

FIG. 4. These huge bones belonged to a giant ground sloth (megatherium) that lived in Panama along with the toxodon about two hundred thousand years ago. When the author sent this picture along with several others to the Smithsonian Institution, a number of specialists came hurrying to Panama to investigate the find.

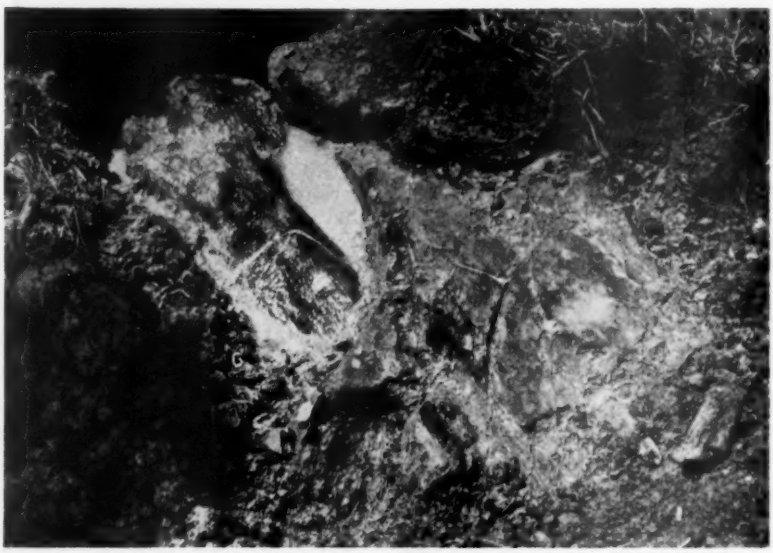

FIG. 5. When this giant ground sloth (megatherium) died, some two hundred thousand years ago, and sank into an ancient spring hole, the disintegrating processes of decay, chemical weathering and mechanical erosion failed to destroy it. An unusual set of natural conditions inhibited and counteracted the destructive processes and left the well preserved collection of bones for the study of present day scientists.

needs to be investigated. From general observations it was obvious that even the tropical environment occasionally produces chemical reactions that cause bones to be preserved in spite of the strong disintegrating processes that are always tending to destroy them.

It was hoped that a chemical analysis of a number of samples of natural bones, fossil bones and petrified bones, which had been found under a variety of conditions, might yield some information that would contribute to the answers to the above questions. At this point the chemistry students[1] assisted us in our attempt to solve the field problems. Although the chart of analyzed samples below may raise more questions than it answers, it does offer material for some very interesting speculations on the subject.

CALCIUM CARBONATE CONTENT OF NATURAL BONE AND PETRIFIED BONE SAMPLES

Nature of Bone	Source of Bone	Probable Age of Bone	Per Cent Calcium Carbonate
Toxodon (Ancient Rhinoceros) (well preserved)	From Ocu, R. P.	About 200,000 years	5.76
Deer Femur (well preserved)	Found about 2 ft. deep in shell mounds near Anton, R. P.	Age unknown. Probably over 500 years	6.15
Fish Vertebrae (well preserved)	Same mounds as deer femur	Same as deer bone	3.47
Turtle Shell Bone (well preserved)	Same mounds as deer femur	Same as deer bone	21.38
Human Bone. Crumbling and powdery	Found in burial urn in a dry cave on Chame Mt., R. P.	Age unknown. Probably several hundred years	0.30
Galapagos Goat Skull (slightly weathered)	Found on sandy beach, South Seymour Island, Galapagos Archipelago	Estimated exposure to the elements 3–4 years	7.25
Cow Jaw (well preserved)	Found on plains of Penonome, R. P.	Estimated exposure to the elements less than 2 years	4.38
Fragments from midsection of humerus of man. (Perfectly preserved sample)	Found in Indian graves near Venado Beach, C. Z. Bones were covered by about 2 ft. of yellow shell bearing sand. Above the sand, and making an abrupt contact with it, is a 4–5 foot layer of humus and coarse sea shells.	Age thought to be over 500 years	10.27

[1] Because of the many hours of painstaking laboratory work required to run the many trials needed to insure reliable results, the author would like to acknowledge the splendid assistance of the following students: William Carson, John Johnson, Robert Jones, Charles McArthur, William Vesser, Jane Williams, Joan Williams and Ramon Young.

Nature of Bone	Source of Bone	Probable Age of Bone	Per Cent Calcium Carbonate
Fragments from end section of above humerus	Same bone as above	Same as above humerus	10.10
Skull fragments from same man as humerus above (well preserved)	Same conditions as humerus above	Same as above humerus	20.77
Miscellaneous fragments: Skull, heavy bones and foot bones (preservation incomplete)	From yellow sand layer at Venado Beach (described above). The bones in this case were in the yellow sand but very close to the junction with the black humus and shells. Fragments fairly well preserved but apparently from bones that were mostly disintegrated	Age thought to be over 500 years	16.33
Skull fragments of man. (preservation poor)	From Venado Beach, C. Z. Found at junction of yellow sand and humus but in direct contact with the black soil. Skeleton totally disintegrated except the skull fragments and a few pieces that appeared to be arm bones.	Thought to be over 500 years old	7.19
Bird bones	Found on plates and in small pots that are usually placed in a large urn and buried with the ancient Venado Indian.	Same age as other Venado bones	10.60

NOTE: Volumetric analyses were made by grinding, oven drying at 100°C., and weighing about 2 gram samples on an analytical balance. Fifty ml. of half normal HCl was added to each sample, then it was digested in a covered flask on a hot plate below the boiling point of the solution. When effervescence of carbon dioxide was complete, the solution was titrated with half normal NaOH, using phenolphthalein as an indicator. Qualitative tests for the presence of the ferrous ion, the ferric ion, and the magnesium ion were applied to each sample. Where any of these ions were present, the above method was considered unreliable and the sample was not listed in the above table. Where the above ions were not present, the equivalents of calcium carbonate were considered to be equal to the loss in the equivalents of the half normal HCl.

This method of analysis may be criticized as having several possible sources of error. However, the calcium carbonate content of different parts of the same bone has been found to vary more than fifty per cent, so a more refined and time consuming method of analysis would offer little advantage in making general comparisons such as these.

COMMERCIAL PHOTOS IN THREE DIMENSIONS

Commercial photographers will soon be able to make three-dimensional pictures with an adaptation of the military trivision system announced by its inventor, Douglas F. Winnek. In an earlier invention of his, single X-ray pictures are obtained that show length, breadth and depth.

A new lens, suitable for use in standard illustration or portrait cameras, is employed. The inventor states that it can "look" around the scene to capture all dimensions. The image is recorded upon the ordinary film or plate. A lenticular, or lens-like, plastic screen, which remains in the film or plate holder, resolves the image into a trivision negative. With present equipment, the photographer can make as many prints as desired.

WORDS OVER WAVES*

ROGER K. HARPER
Illinois Bell Telephone Company, Chicago, Ill.

Even though our apparatus may look like a page lifted from a wizard's catalog, I want to reassure you about our program. It will be a non-technical demonstration. We would like to take you on a trip into a new electronic wonderland to see what is going on in modern day communications. I should explain to you that the telephone company really is in the *transportation* business.

We are in the business of shipping *your voice*—and such other things as television and radio programs, typewriter signals and pictures—shipping them from one place to another. Now we do not ship them by truck, or rail or plane—and even rockets are too slow. We transport your voice on something much faster—something that travels at the speed of eleven million miles a minute!

The tune is "Over the Waves"—our theme song. It is telling us musically that we ship your voice by *electrical waves* at 11 million miles a minute. That wavy green line you see is a picture of the waves carrying the music to the loudspeakers. Strange as it may seem, a telephone line *does not* carry your voice. It carries a vibrating electric current with the imprint of your voice on it. Now as I speak you can see the waves that are carrying my voice on the screen—words passing over waves. Seventy-four years ago, Alexander Graham Bell proved to the world that speech over a wire was possible by turning sound waves into electrical waves. Ever since, telephone engineers have concentrated on *electrical waves*—how to produce them and how to send and receive them. Your telephone company actually custom-builds waves to carry your speech, television and the other things I mentioned a moment ago.

You are hearing about the lowest fundamental speech sound and there is a picture of it. When you say "Robert," the tone you produce on the "R" is close to this one. Sound is a vibration of the air and this particular sound vibrates 60 times a second. So we call it a 60-cycle tone. Now we shall let a 180 vibration tone out. That vibration at 180 times a second is a common fundamental tone in your speech. As the number of vibrations increase, you will notice the tone goes up. Here is 480 vibrations. Speech has its greatest power around this point. Here comes 1,000. With such frequencies, speech power begins to drop off. Let us go all the way. With sound that vibrates 8,000 times a second, we hear less of speech, but more of musical tones and

* An illustrated lecture delivered to the Physics Section of the Central Association of Science and Mathematics Teachers at Chicago, November 24, 1950.

sounds of nature—animals and birds. The threshold of human hearing goes much higher—to somewhere around 15,000 vibrations, but it is in this field of 60 to 8,000 cycles that we get the most from the experience of hearing. Those are the ingredients. Thousands of individual tones. Of course, speech actually is made up of countless combinations of those tones. A simple, one-syllable word may have dozens of tones vibrating at the same instant.

We send your words over the waves—over electrical waves. But did you know that there are all kinds of electrical waves? There are very long waves and extremely short waves—and all sizes in between. We use many different kinds in the telephone business, but they all have two things in common: First, they will carry your telephone conversations; and, secondly, they travel at about the same speed. Here are models of some of these kinds of waves.

This one we call Long Tom Wave. He is one of the most long-legged members of the family with an average wave length of 125 miles. Here is one way to think of him: Tom takes steps nearly 125 miles long as he flashes around on telephone lines at 11 million miles a a minute. At that speed, he sets a pace of 1,500 steps a second. Technically, Tom would be known as a 200,000 meter wave with a frequency of 1,500 cycles.

Tom and many members of his immediate family work for you every day moving local telephone messages over lines like those in your neighborhood.

Simple as it sounds, Tom's life is complicated by a balancing act I think I can show you in this next experiment. It is really in the form of a little melodrama with a cast including two waves who are romantically inclined.

Right now this couple is very unhappy. They are locked in this wave-making machine and want to go places. If they were the electrical waves of a telephone call, they would want to go down these two pathways, which are like the two wires of a telephone line, and meet in some way down here at the end.

First, we release them by turning on the machine. There! But what is wrong? They went zipping down their separate electrical pathways here, all right, but bumped into trouble. Perhaps we can see what it is if we put a little light on the subject with this pocket-sized model.

The lighted tube shows the pathway of our two friends. They left here and went all along here to this end.

But if you will look closely, you can see where they are having trouble. These dark places are spots where the waves are stopped—standing still—and believe me, that is serious trouble for a guy and a gal who usually step around at an 11 million mile a minute speed.

If you look very close, you will see the dark areas are really the villain of our story.

One villain has just about given up. He is the impedance in the electrical pathway, but they are giving him the bum's rush by going through to the end, as you can see by the light. One other villain is keeping them apart and this fellow is really tough. In the electrical rogue's gallery he is known as resistance and right now he is throwing his weight around this whole area.

Do not worrry if you cannot see him. I cannot either for the resistance in this case is the air, a very rough customer as resistance goes. As the waves went skipping down their paths, intent on joining hands down here, resistance smacked up against them like a brick wall and bounced them back against many other waves on their way out. The result is a head-on collision at these dark spots.

Here, then, are standing waves—an unhappy situation because all waves want to go places and accomplish something.

Let us see if we can solve their problem. First, we can get rid of Old Man Resistance by using a good conductor, like this metal bar. and crossing, or shorting the two pathways. Watch closely now! Did you see what happened? Remember the two dark spots? Well, they are gone now, but here are two more.

By using this second, pocket-sized light we can get a better view of conditions here. At this point there is a strong indication of voltage, here it is down somewhat and here out. And, in this way, we see how energy is drifting into space all around the pathways.

So, removing the resistance did not help us and, of course, too much resistance did not work, either. What we need is something that will balance out just right. A telephone may be the solution. If this telephone does provide just the right amount, the line should be balanced.

We will try it by placing it at this end of the pathway and move it closer. And there it is—success!

The obstacle was removed, the waves no longer have to fight electrical villains, and can live happily ever after.

In your daily telephone service, this principle is extremely important. Telephone lines must be properly balanced to avoid the ill effects of the standing wave by providing for just the right amount of impedance and resistance. Without that balance, you would not be able to hear the people that call you very well and we would not have much to demonstrate here today! But as you have seen, a solution was found and we can continue, not only with our demonstration, but with the good telephone service you expect.

So much for Tom. It is time to introduce another member of the electrical wave family.

This one we call Carrie Carrier Wave. You will notice that she is shorter than Tom—in fact she takes steps that are only about 5 miles long at the rate of 36,000 steps a second. Carrie is a wave we use to move telephone calls between cities. While Tom needs two wires all to himself to move your conversation, Carrie and her sisters move many conversations all at the same time on a pair of wires on carrier systems. So, with Carrie's help, we can move dozens of long distance calls simultaneously over the same line. Even though she would like to take credit for telephone carrier systems, Carrie does not do the whole job herself.

She is helped out by this very useful and interesting material—quartz—which when sliced down into very precise crystal wafers—enables Carrie to travel on the same wires with other conversations. The peculiar vibrating qualities of quartz crystals make this possible. I think I can show you what I mean with this demonstration crystal which is connected by wire to our loudspeakers.

When I tap it with my finger, it starts to quiver from the mechanical energy of the blow and immediately shakes itself into an electrical convulsion which you are able to hear. Mechanical vibrations are converted to electrical vibrations.

When I hold it up against my voice box—which is larynx to my doctor and Adam's Apple to my friends—speech, or a reasonable facsimile should come out of it so you can hear what it sounds like when you talk without your mouth. Again, vibrations become electrical waves in the crystal as they do in microphones and the pick-up arm of a phonograph.

It is this vibrating quality of the crystal that makes it important to Carrie and the other waves that are traveling over the same wires with her. If we did not have some way of sorting out the waves at each end of the line, why you might be talking to one person and hearing the response of someone else. The crystal does this sorting-out job.

By vibrating so precisely, the crystals separate Carrie from other waves—by counting the number of steps they take each second. I can show you that with this tuning fork. This one vibrates at 1240 times a second. By placing it on the table, the crystal picks up this vibrating tone. If this unit was specially treated to vibrate at just this one frequency, it would reject all others.

The crystal, you see, is sort of a traffic cop for Carrie and her sister waves as they zoom down the super telephone highways between cities—keeping each of them in the lane which will take the conversation they are carrying to the right telephone.

This next one is a pretty popular member of the wave family these days. You have been reading a lot about it in your newspapers, and

if you own a television set, this will be like meeting an old friend. We would like to present Coaxial Katie. This wave takes steps of 650 feet at 1½ million times a second. And as you have gathered from her name, we send her along coaxial cables. Katie carries telephone conversations just as Tom and Carrie do, but she is probably better known for carrying television programs between cities.

Here is a piece of the coaxial cable that Katie travels along. You will probably have difficulty in seeing it so we have made up a large scale model. This cable is a highly-developed super telephone highway. As you can see, it has eight tubes arranged in a circle. The wire straight down the middle is the common axis of the tube. Common axis, shortened, became coaxial, giving the cable system its name.

Electrical waves carrying 600 simultaneous telephone conversations can travel on a pair of these tubes. And it takes one tube to transmit a television program. Television programs originating in New York are now coming to this area over coaxial cable.

Vacuum tubes act as boosters on a voice journey. Years ago, before the earliest tube, telephone operators sometimes acted as *repeaters* on a long distance call by repeating the customer's words at cities along the line because the electrical energy could not go all the way without help. Ever since, this tube, as an electric repeater, has been doing a more effective job. You will find hundreds of thousands of them in use in telephone buildings today.

Just recently a new baby joined this family. I say baby because you will probably have to take my word that I am holding it here. This is an electronic device which can do most of the work of this tube. It is called a "transistor."

It has many advantages. The most obvious is size, for with the transistor it is possible to build amplifiers of very small size as compared with the older, larger tubes. It works immediately with no time lost for warming up and is more durable because it is constructed without the customary glass envelope.

There are two transistors in this transparent box and again you will have to have faith. I can hardly see them myself, because they are no larger than a pair of capsules. Most of the space in the box is filled by a battery, loudspeaker, and so forth.

One of the transistors produces several tones. It is like a pencil-point organ. Now I shall turn this switch and put Transistor Number Two on the job. He is hiring out as a strong man and will show us how he can boost that tone. As we put the transistor to work, you can hear how well it does its job and also see the improvement on our picture.

This is Sam. As you may have guessed by his clothing, he is the wave we use to transport telephone conversations from ship to shore.

Sam comes from another branch of the Wave family and is commonly called a radio wave. These waves do not carry your speech along wires or cables but take their steps right through the air. Sam is still shorter, you will notice.

Oscar is the wave that takes telephone conversations overseas to South America, Africa, Europe—all over the world, in fact.

It is our responsibility to safeguard your conversation to assure privacy should anyone with a radio receiver be tempted to eavesdrop on your call. We do this by using a device called an "invertor." The invertor makes the conversation sound like gobbledegook to the eavesdropper by cutting Oscar in half—and putting the top half of him on the bottom as he travels overseas.

If my voice went from here to London by telephone, it would sound like this on the way over the Atlantic Ocean. In England, similar equipment unscrambles the message so it is intelligible to the listener. The invertor, you see, just turns everything upside down.

We would like to have you meet Mike. Mike is the wave we use when you talk to automobiles and other vehicles in *mobile telephone* service.

This little fellow—Billy Microwave—is the baby of our wave family. Microwave means an extremely short wave—that is how he got his name. Even though he is tiny, he can still travel at the 11 million-mile-a-minute clip of his elders and sometimes even faster. His steps are only about 3 inches long, but he takes 4,000 *million* of them each second. He is the wave we use to send telephone messages and television programs by *radio relay* systems.

Microwave radio relay systems are now working between Chicago and Milwaukee, New York and Boston, and Chicago and New York.

Here we have a miniature radio relay system with a transmitter there and a receiver here.

In setting up this type of system, telephone engineers must provide for the unusual behavior of microwaves. They like to travel off into space without bouncing back to the earth as lower frequency radio waves do. To solve that problem, they must be moved in gaps or jumps about 30 miles apart—to catch them before they are lost at the horizon. To do this, towers are built high enough to clear obstacles like hills and buildings.

These towers serve as relay points. High frequency energy leaves one tower, goes to another some 30 miles away, is picked up and relayed on to the next tower. The New York-Boston system has 7 towers and the Chicago-New York system 33 towers between the two cities.

Now we are going to move messages between these two points to show how microwaves can be used in telephone service.

Each time we move our hands into the field of microwave energy our words are cut off, proving that our speech is concentrated in and moving in this area.

In actual practice, a radio relay system like this would move not only one telephone conversation, but bundle up hundreds of them at the same time—with the help of the crystals that you saw when we introduced Carrie.

The music you now hear is being carried by our miniature radio relay system. By using a metal plate I can put on my own version of a "Stop the Music" show.

People sometimes ask what the advantages are in using this upper part of the spectrum for communication. For one thing, it is practically free from static and man-made interference. A microwave radio relay system is just as reliable as a wire line. It is very economical to operate because the electrical power required is exceptionally low. The receiving equipment in a tower like this works very efficiently on only a few tenths of a watt!

Here is one way to prove that the towers must be in line of sight. When I turn the transmitter the music gradually fades away and then it is lost. Because microwaves are like light waves, I can use this ordinary mirror and reflect them back to the receiver.

Another interesting experiment is to use an insulating material like this rubber tube to conduct the energy. If we use it as a garden hose, we might be able to sprinkle music into the receiver and aim it in any direction we choose.

By swinging the transmitter back into line of sight, we can bring the music back again.

You will notice we are using directional horns on this equipment. A horn concentrates the waves in a forward motion and is a lot like a football cheerleader's megaphone. An actual relay tower has an opening ten feet square to allow the waves to stream out. In order to concentrate them directionally, that horn would have to be about 600 feet long.

This would not be very practical so another interesting characteristic of microwaves was put to work. Like light waves, they can be focused with a lens. I can demonstrate that with this glass which is much like a giant reading glass. We can build up the volume of the music with this glass. You can hear the improvement.

Here is another type of lens developed specially for radio relay systems. Instead of glass, this cone-shaped structure has insulating material spaced so accurately it corresponds to the molecular structure of a reading glass.

This horn-lens combination will be vital in the new Chicago-New York radio relay system because it can increase the energy here at

the transmitting end by ten-thousand fold. By doing the same at the receiving end, the combined improvement becomes 100 million fold. In that way we can operate with a very small amount of power—an important point in making this an economical system.

Developments like this in high frequency telephony are by no means limited to long distance service. There are applications in local and mobile telephone service, and service in rural areas.

The big black box is a high powered generator of microwaves. You will recall that the microwaves represented by Billy—the ones we use in radio relay telephony—are about 3 inches long and take 4,000 million steps a second. This machine produces even *smaller* microwaves. If we push them out of the equipment with a peak power of 30 kilowatts, we can ignite the gas in a lamp, making it glow without any wires.

One practical problem in moving telephone communication through space on high frequency waves is to get the greatest possible concentration of energy.

You have seen how microwaves can be beamed—or directed—just as light is beamed in a searchlight. Here you can see we are not getting the energy out very far this way: something like 8 or 9 inches. By adding the directional horn, the energy should carry much farther, in fact, more than double our distance. In this way we get *greater* reach with the *same* power.

You saw how microwaves pass through insulating materials—or non-conductors as engineers call them. Here again is a solid piece of rubber usually considered a good insulator. We shall place one end at the opening and see if we can move this high frequency energy through the rubber so it will come out here. Something is happening because the tube is getting warm.

Here is another excellent insulator—a material called steatite. There is more electrical resistance in this one piece than in a pair of copper wires wound around the earth *several hundred times.* This is a real test for microwaves. Here again, you see the energy passes through one of the most efficient insulators without difficulty.

Now we shall take one of the best insulators of all—the air—and quickly make a column of it by holding it in on four sides with this metal tube. Energy can be sent through this column of air. This tube, or wave guide as it is called, is very convenient because, in this way we can pipe the waves to any place we choose. If you were to visit a radio relay center, you would see wave guides like this rather than wires.

Even though we can move the energy through an insulating column of air, we cannot get it to pass through good electrical conductors like copper and steel. Microwaves disappear into space when we try

to move them on an ordinary wire.

This brass plate, for example, normally is a good conductor of electricity. When we place it in the beam of microwaves, it cuts off the light. But it can serve as a good reflector by reflecting energy back to this lamp.

An ordinary piece of wood is usually a fair insulator. The waves are not affected as they pass through.

Water is a good conductor of electricity and in this next experiment we shall see what effect it has on microwaves. The waves seem to pass through the glass easily. By pouring water in, however, the energy is stopped, proving that water, a conductor of electricity, will not pass these high frequencies. Because microwaves can be reflected like light waves, we can use the water as a reflector, aim the waves at the water and the reflection lights the lamp.

So far you have seen how this energy affects small lamps. This gas-filled tube gives a profile portrait of microwaves as they move along leisurely at 11 million miles a minute with every bone in their bodies vibrating 10 billion times a second.

First I shall place the tube before the source of energy to ignite the gas. Instead of stopping at the end of the tube as our two waves did over there, Billy Microwave dances right on into space. We shall stop him with a metal plate and reflect him back into the tube. And there we have another case of standing waves. These waves are much shorter, only an inch long.

These things are not mere toys or gadgets. They are marks of progress in the telephone art—steps in the direction of making *your telephone service* better all the time.

The technical know-how needed to harness all of the different kinds of electrical waves has come out of the continuing "search for a better way" that goes on daily in the Bell Telephone Laboratories.

Incidentally, it is the kind of progress you find only in countries like ours—the free enterprise nations of the world.

A FILM FOR GIRLS

The changes occurring in a girl's body as she approaches adolescence and the impending cycle of menstruation are the subject of a new educational motion picture entitled GROWING GIRLS, released by Encyclopaedia Britannica Films.

Produced as an aid to the school in its increasingly important sphere of physical hygiene instruction, GROWING GIRLS is designed to help children gain a healthy and intelligent understanding of human growth and development and particularly the alteration and evolution of the adolescent body. The film aids in eliminating fear and establishes wholesome attitudes.

The one and a quarter reel, black and white film may be purchased for $60 from Encyclopaedia Britannica Films, Wilmette, Illinois.

MODEL FOR INTRODUCING CONGRUENT TRIANGLES

ETHEL L. GROVE
311 B Cedarcrest Apartments, Tuscaloosa, Alabama

This and the remaining models suggested in this series are related to topics usually introduced in early fall units. They are, therefore, being described in this and the following issues so that they may be prepared in advance for fall use.

I. Construction
  A. Materials
    1. One cardboard rectangle approximately 14″×19″.
    2. One cardboard disk 15″ in diameter.
    3. Paper fastener or bolt, scissors, pen, and India ink.

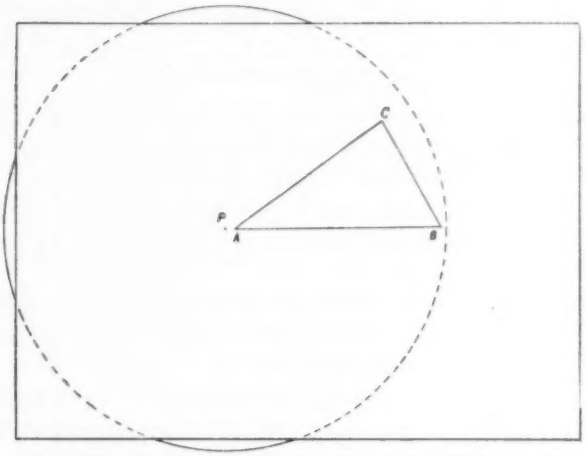

FIG. 1. Model for Introducing Congruent Triangles.

  B. Steps in Construction
    1. On the cardboard rectangle locate point P 7″ from the top, bottom, and left-hand edge.
    2. Slightly to the right of P draw any general $\triangle ABC$ with line AB about $7\frac{1}{4}$″ long. Cut out $\triangle ABC$.
    3. On the cardboard disk construct nine triangles as shown in Figure 2. The general position of these triangles may be determined by attaching the disk temporarily back of the rectangle with a paper fastener or bolt through P and the center of the disk, and by indicating points A, B, and C for each of the nine triangles as the disk is rotated.
    4. Complete ▲ 3, 5, and 7 congruent to $\triangle ABC$ and indicate two angles and included side, two sides and included

angle, and three sides equal respectively on them.

5. Complete other triangles making only one angle and side equal, three angles but no sides equal, two sides and angle opposite one of them equal, two angles but not the included side equal, and two sides but not the included angle equal respectively, as shown in Figure 2.
6. Shade all triangles on the disk.
7. Attach disk back of the rectangle again with the paper fastener or bolt through *P* and the center of the disk.

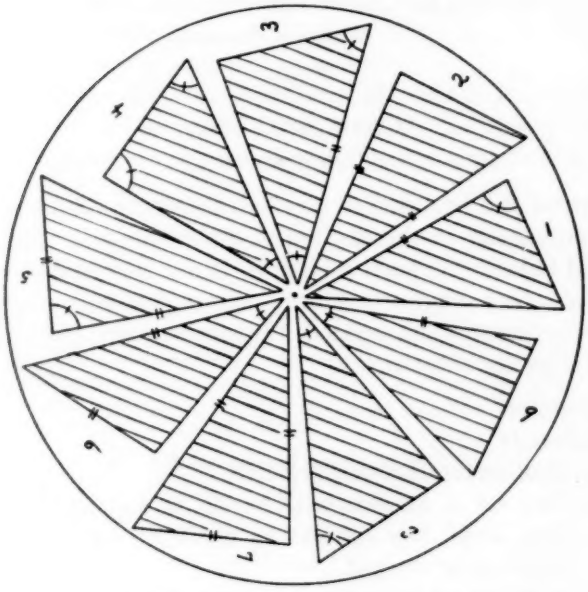

FIG. 2. Model for Introducing Congruent Triangles.

II. Use

A. Pupil Experimentation

1. Place this model on the bulletin board before congruent triangles are introduced and let the pupils discover by observation what conditions make the triangles on the disk coincide with the triangle in the rectangle.
2. In class discussion urge the pupils to suggest conditions for congruency and to develop proofs for their hypotheses.

B. Teacher Demonstration

1. Use this model in class to illustrate superposition in the case of congruent triangles and to emphasize the effect of altering any one of the three required parts.
2. Place the model on the work table so that pupils may examine it later if they wish.

III. Other Materials

This model may be made from transparent plastic if the materials and equipment are available. In that case $\triangle ABC$ would not need to be cut out and other variations of the non-congruent triangles could be used.

SUBSTITUTE DEVICES FOR ILLUSTRATING EQUATIONS

EWART L. GROVE AND ETHEL L. GROVE
University of Alabama

AND

CHARLES E. SCOTT
Cleveland, Ohio

The natural and best device for demonstrating the basic principles of simple equations, in the opinion of the authors, is a beam balance or Harvard balance. If such a balance is not included in the mathematics laboratory equipment and cannot be borrowed from the science department when needed, the same procedures may be used with the following substitutes.

I. Construction
  A. Materials
    1a. One meterstick or yardstick.
    b. One set of weights with hooks, or substitutes for these.
    c. One small box containing chalk or coins to give it any convenient weight.
    d. A drill and wrapping twine.
    2. One box of Tinker Toys.
  B. Steps in Construction
    1a. Drill a hole equidistant from the ends and from the sides of the meterstick and attack twine by which the balance can be hung or held.
    b. Drill several holes similarly spaced at each end of the meterstick from which the weights may be suspended.
    2a. With small Tinker Toy sticks make a fulcrum with a pointed stick in the center spool, as shown in Figure 2.
    b. Make the balance beam from a little longer sticks with a spool at each end so that any combination of sticks and spools may be added.

II. Use
  A. Teacher Demonstration
    1. To illustrate the subtraction axiom

a. On the meterstick beam, balance the box and one or two small weights at one end with the necessary combination of weights on the other end. Then find the weight of the box by removing the other weights from that end and the equivalent weights from the other end.

b. On the Tinker Toy beam, balance a spool with one or two small sticks attached by the necessary number of sticks on the other end. Then show the value of the spool without the sticks by removing the small sticks from the spool and the equivalent weight in sticks from the other end.

2. To illustrate the addition axiom

a. On the meterstick beam, balance the box minus a few coins or pieces of chalk with the necessary number of weights on the other end. Then complete the unknown

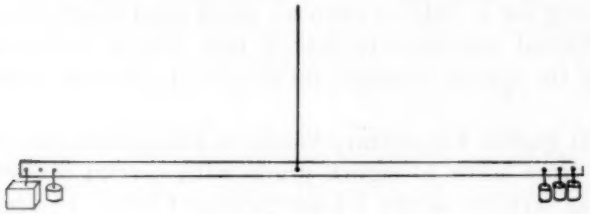

FIG. 1

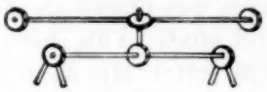

FIG. 2

by adding the coins or chalk to the unknown and the equivalent weights on the other side.

b. On the Tinker Toy beam, balance a spool with short sticks in all but one or two holes with the necessary number of sticks on the other end. Then complete the fan by adding the one or two small sticks to the spool and balancing with the equivalent weight in sticks on the other end.

3. Similar illustrations can be worked out for the other axioms.

B. Pupil Experimentation

Individual pupil investigation after class demonstration may help some pupils to grasp and retain the idea that an equation is a statement of balance and that this relationship must be preserved. Pupil experimentation with these devices before class discussion seldom develops these desired concepts.

AN INTRAMURAL SCHOOL SCIENCE SERVICE

MURIEL BEUSCHLEIN
Parker Elementary School, Chicago, Ill.
AND
JAMES M. SANDERS
Chicago Teachers College

With greater emphasis being placed on elementary science no occasion should be neglected for improving and enriching the program. Field trips are often difficult to schedule, however, the outdoors can be brought into the classroom in a limited but effective way. Reading science imparts facts which though important cannot substitute for the living experience of seeing, feeling and touching live material. The actual experience of watching a cray-fish molt has more meaning for a child or even an adult than pages of reading or pictures. Special attention to satisfy this natural curiosity and to supplement the regular program takes careful planning and organization.

Science at Parker Elementary School is a departmental subject for the pupils from sixth to eighth grade with special interest groups organized as sections of the Parker Science Clubs[1]. The meetings of these sections are held during recess and sometimes lunch periods. For these groups, emphasis was placed on providing live specimens for their observation and study. This collection included animals from each of the classes of vertebrates as well as many invertebrate species. Interests ranged from raising white mice and hamsters to making insect cages for observation of emerging moths.

The science room was a source of wonder to the lower grade pupils who heard tales of alligators, snakes and frogs. Many a bright-eyed youngster begged for permission to visit. Because of this school-wide interest the Service Committee of the Parker Science Clubs came into existence.

This science service project has served its four-fold purpose. In developing the plan these objectives were foremost:

1. To promote science interests and to give lower grade pupils experience with live material, to widen the range of contacts with their environment.
2. To encourage self-expression and freedom of communication.
3. To foster the democratic ideal of sharing with others and to develop cooperation and a responsible attitude.
4. To supplement science teaching throughout the school by pro-

[1] Parker Science Clubs are affiliated with Science Clubs of America. M. Beuschlein and James M. Sanders, Sponsoring the Elementary School Science Club, in press.

viding more opportunities for observation, exploration, and interpretation.

With the cooperation of the principal[2] and the willingness and enthusiasm of the science club members the service was initiated in October 1950. A mimeographed letter[3] and list was delivered by a special committee to each of the teachers whose pupils did not participate in the departmental science program. This letter served as an order blank for one month. A similar list was issued each month and when returned was filed as a record of the transaction.

Pupil management handled the details. All reports, changes and returns were posted for the official record. A secretary copied orders which were given to the chairmen of the various groups. These committee chairmen were responsible for the delivery, care, feeding and return of the animals. Available material included hamsters in individual cages, six kinds of fish in separate aquaria, terraria containing salamanders, turtles, snakes, toads, frogs and grasshoppers. Cultures of fruit flies and mealworms as well as developing snail eggs and various other invertebrates were on the list. The alligator, whose habitat was too large to transport was loaned for only short periods.

Service on a committee was an earned privilege. This required looking up information and preparing speeches on the life history and care of one specific animal. Regular class work could not be neglected so selection also depended upon finished assignments. The speeches were made at the time of delivery and further questions were answered on later visits. This served several purposes as the room teacher had no preparation to make regarding the borrowed specimen, she did not have to handle it in case she objected to snakes or such, and her children benefited from the accurate information. Both the younger pupils and the speakers were stimulated to seek further knowledge. The school library reported innumerable requests for pictures, reference books and animal stories. A Chairman served for one semester. His assistants were chosen for the week to give opportunities to a greater number of pupils.

To facilitate operation with the least confusion and disturbance in classes, recess periods were used for checking and feeding the loaned animals which were usually kept for a week. By this time the younger children had much to report to the committee about their experiences. The teachers were appreciative of the service. There were no new duties or responsibilities added to a busy schedule. Food was provided and no unnecessary confusion resulted when cages were cleaned. In many instances both the children and the teacher asked to have the aquaria changed or the frogs fed in their presence.

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[2] Miss Bernice Boye, Principal of Parker Elementary School, 6800 Stewart Avenue, Chicago 21, Illinois.
[3] Letter and list appended.

The baby alligator was the most popular loan. The committee permitted each child to hold him while they discussed the body covering, slit-like pupils, strong tail and features which differed from the crocodiles. A family of nine hamsters received the most requests for long term loans. As soon as the young hamsters matured another family was provided so that their group living could be observed.

From the number of requests and the enthusiastic response which the new project received, its success was evident and time and effort were well rewarded. The learning and teaching situations provided were unique in the lives of the children and most of the faculty. It would be difficult to measure the value of the experiences to the participating pupils. In the service groups interest never lagged. Growth in ability to meet new situations could be recognized. A closer feeling between the children of the upper and lower grades developed through this sharing of information and experiences.

Any worthwhile medium which provides stimulation, evokes interest with the inevitable desire to communicate is valuable to the classroom teacher. With the above plan there was a constant source of material available to enrich the teaching of science *and the tool subjects*. There were many opportunities for correlation with spelling, language, art, reading and oral and written composition. It afforded supplementary science lessons beyond the course of study requirements.

While the undertaking was designed to fit the needs and the program of one specific school it is flexible enough to be adjusted to other situations. Many schools which do not have departmental science might develop an exchange service which would offer more opportunities through the sharing of material. It need not be a costly project. Cages and terraria can be made at school, large potato chip cans may be used as substitutes for cages. Battery jars, or large pickle jars will serve for aquaria. The animal specimens to be used can readily be collected or borrowed from hobbyists. Frequently such are available from children who by circumstances may no longer keep any pets at home. All the animals for the service project were collected by the teacher, pupils or interested persons[4] with the exception of the alligator which was a gift from a member of the club. A similar service project lends itself to a plan of wider scope. Perhaps at some future date it may be expanded to accomodate a district or even a whole school system. It is the answer to a science teacher's dream.

SCIENCE SERVICE

The following specimens are available for demonstrations. If you want your room to see any of these please indicate the date and hour on the blank space

[4] Chicago Teachers College, Science Department through courtesy of Dr. James Sanders, Cook County Forest Preserve District through courtesy of Dr. David Thomspon, senior naturalist.

opposite each item with the length of time you wish to keep the material.

We will send the animal to you and the pupil who brings it will explain its care and facts of special interest to your class. Any questions unanswered can be referred to room 304. We shall also send a messenger to pick up the specimen after you are finished with it.

Science Service Committee of the Parker Science Clubs affiliated with the National Science Clubs of America.

Vertebrates
- Mammals
  - hamsters, young _____
  - hamsters, adult _____
  - white rats _____
- Birds
  - nests mounted and identified _____
- Reptiles
  - turtle _____
  - snake _____
  - lizard _____
  - alligator _____
- Amphibia
  - salamander _____
  - toad _____
  - frog _____
  - tadpole _____
- Fish
  - blue gills _____
  - Gambusia _____
  - Florida minnow _____
  - goldfish _____
  - guppies _____
  - black mollie _____

Invertebrates
- Arthropods
  - Crustacea
    - crayfish _____
  - Insecta
    - Orthoptera
      - grasshoppers _____
      - camel crickets _____
    - Hemiptera
      - water boatman _____
    - Coleoptera
      - Tenebrio beetles (larvae pupae and adult) _____
      - whirligig beetles _____
    - Diptera
      - fruit flies _____
  - Also various mounted insects _____

Annelida
Earthworm
Lumbricus terrestris _____
Diplocardia _____
Enchytraeus _____
Mollusca
snails and snail eggs _____

Conservation Material
Bulletin Board _____
Posters _____
Pamphlets in sets of 50 _____
Our Land—Our Spirit _____
This Is Our Soil _____
Let's Practice Soil Conservation _____
Trees for Tomorrow _____
Elements of Forestry _____
Forest Trees of Illinois _____
Know Your Watershed _____
A Story of a Lake _____
Invitation to Birds _____
Illinois Mammals _____

Current Science Publications _____
Science News Letter _____
Scientific Monthly _____
Science _____
Scientific American _____
Farm Journal _____
Outdoor in Ill. _____
Illinois Wildlife _____
Living Wilderness _____
Junior Nat. Hist. _____
Living Museum _____
Nature Magazine _____

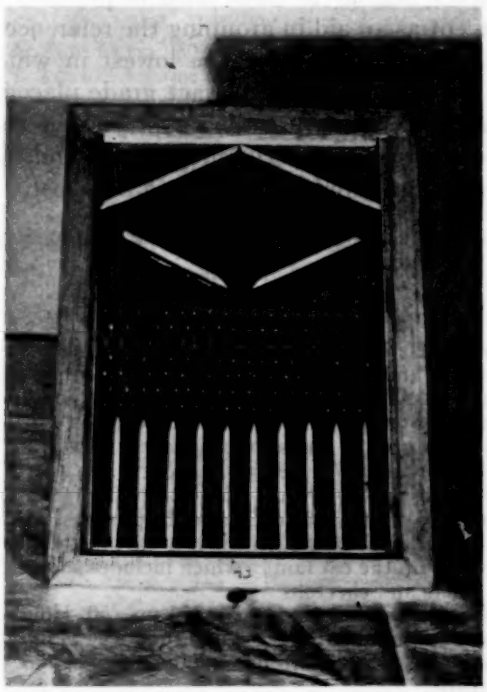
FREQUENCY DISTRIBUTIONS WITH SHOT

FRANK HAWTHORNE
Hofstra College, Hempstead, N. Y.

The device pictured, sometimes called a quincux, is designed to produce various frequency polygons by the distribution of shot. The basic construction is not unlike that of a pin-ball machine. By tipping the frame all of the shot are made to collect in the upper portion and then to flow through the gap in the center and, after deflection by the pegs, to form a histogram in the slots at the bottom. With a little practice, one can produce variously skewed as well as normal distributions.

No great skill is required to build a quincux. The one pictured is made with a plywood bottom, pegs cut from sections of applicators

and partitions fashioned from discarded cream cheese boxes. The shot should be small and spherical. Use should not be made of the "shot" of other shapes sometimes furnished to schools for use in specific heat experiments. The shot used in the contrivance pictured is made of lead but steel shot would be better for the lead tends to discolor the whole interior. The covering glass should fit snugly against the pins and partitions, otherwise, some of the shot may become lodged. The outer frame and glass cover should not be firmly attached until the optimim amount of shot has been determined by trial. It requires less shot than I had expected.



The device has several uses. Among these are the obvious ones associated with the teaching of statistics and related subjects. Some teachers might find it useful in explaining why so few (or so many) students received certain grades.

Education makes people easy to lead, but difficult to drive; easy to govern, but impossible to enslave.—LORD BROUGHAM

Hair trimmer, recently patented, is a short-tooth comb-like device, with an elongation for a handle, made of two flat pieces fitting closely together. Inside is a recess to hold a thin double-edge razor blade which can be adjusted to regulate the cut.

THE ELEMENTARY SCHOOL SCIENCE LIBRARY
For 1949–1950

PAUL E. KAMBLY
School of Education, University of Oregon, Eugene, Oregon

This seventh list of reference books for elementary school science is intended to supplement those previously published.[1] The purpose, like that of preceding lists, is to suggest to elementary school teachers, books that are supplementary to basic text series either for their values as sources of information or for recreational reading. The subdivision topics, similar to those used in previous lists, are of no significance except as an aid in grouping the references.

The grade levels indicated are the lowest in which it is recommended that the books be used. Exact grade placement is difficult because of variations in pupil reading ability as well as differences in how the books are used. The recommendations and the brief annotations are based on an examination of each book listed.

REFERENCE BOOKS FOR ELEMENTARY SCHOOL SCIENCE

Animals
(See also list of books on birds)

	Grade	*Price*
Frogs and Toads. By Herbert S. Zim. 64 pp. '50. Morrow[2].....	3	$2.00
This book outlines and illustrates the life cycle of frogs and toads. It also provides information concerning homes and food for frogs or toads kept as pets. The other science books written by this author are listed in the annotation under *Owls.*		
Cats. By Wilfrid S. Bronson, 75 pp. '50. Harcourt.....	4	2.00
All kinds of cats are described and illustrated. Younger children can learn a great deal about cats from the pictures. There are rules for raising healthy cats. In the last part of the book Mr. Bronson takes up the cat family which includes such animals as lions, tigers and cheetahs.		
Chip the Dam Builder. By Jim Kjelgaard. 233 pp. '50. Holiday	4	2.50
A very interesting story about beavers and their way of living. This book should help anyone to understand the meaning of "balance in nature."		
The Red Squirrel Twins. By Jane Tompkins. 122 pp. '50. Lippincott.....	2	2.25
The life of squirrels is well described. There may be some objections to squirrels talking and exhibiting considerable capacity to reason.		
Song of the Seasons. By Addison Webb. 127 pp. '50. Morrow...	4	2.50
This is the story of the behavior of animals such as squirrels, opossums, bees, birds, raccoons and bears during the four		

[1] Kambly, Paul E., "The Elementary School Science Library," SCHOOL SCIENCE AND MATHEMATICS, 44: 756–767, November, 1944. "The Elementary School Science Library for 1944–45," SCHOOL SCIENCE AND MATHEMATICS, 46: 13–16, January, 1946. "The Elementary School Science Library for 1945–46," SCHOOL SCIENCE AND MATHEMATICS, 46: 865–870, December, 1946. "The Elementary School Science Library for 1946–47," SCHOOL SCIENCE AND MATHEMATICS, 48: 202–205, March, 1948. "The Elementary School Science Library for 1947–48," SCHOOL SCIENCE AND MATHEMATICS, 49: 237–240, March, 1949. "The Elementary School Science Library for 1948–49," SCHOOL SCIENCE AND MATHEMATICS 50: 209–212, March, 1950.

[2] Publishers and their addresses are listed at the end of this section.

	Grade	Price
seasons. Springtime is described as the season for babies, summer for learning, autumn for feasting and winter for rest. The illustrations in black and white drawings are excellent.		
Masked Prowler. By John and Jean George. 183 pp. '50. Dutton. This is a book about a raccoon that lives in a Michigan forest. It is a well written story as are the authors' books on *Vulpes, The Red Fox* and *Vison, The Mink*	6	2.50
The Wahoo Bobcat. By Joseph Wharton Lippincott. 207 pp. '50. Lippincott. The story of a wildcat living in the Florida water prairie wilderness. Children will be impressed with the problems of survival that confront the bobcat.	6	2.50

Birds

Owls. By Herbert S. Zim. 64 pp. '50. Morrow. The seventh in a series of science picture books by the same author. The others are *Snakes, Homing Pigeons, Rabbits, Goldfish, Elephants,* and *Frogs and Toads.* This book about owls is an excellent means of convincing children that these birds are extremely useful to man.	3	2.00
Ruby Throat. By Robert M. McClung. 52 pp. '50. Morrow. This is a picture-story of one year in a hummingbird's life. It is set in large type and is very well illustrated in color as well as black and white. The author is assistant in the Department of Mammals and Birds at the New York Zoological Park.	3	2.00
Bird Islands Down East. By Helen G. Cruickshank. 123 pp. '49. Macmillan. This book tells of the lives of Arctic Terns, Great Blue Herons, Cormorants, Herring Gulls and Laughing Gulls and other birds. It also includes useful material on the work being done for their conservation.	6	2.75
The Quails. By Edward S. Spaulding. 123 pp. '49. Macmillan. This book discusses in detail these kinds of quail—Valley, Desert, Mountain, Massena, Scaled, Bobwhite, and Masked Bobwhite. The book is intended primarily for any outdoorsman and is too technical for most youngsters.	6	6.00

General Nature Study

Beginner's Guide to Fresh-Water Life. By Leon A. Hausman. 128 pp. '50. Putnam. This book includes over 250 of the most common forms of animal life found in fresh water. There are black and white drawings of the animals described. This is a pocket size book for easy reference in the field.	4	2.00
Nature Crafts. By Ellsworth Jaeger. 128 pp. '50. Macmillan. The projects discussed and shown by detailed drawings require materials that come from fields and woods. Only a few fundamental tools are required to make a craft hut and furnishings, Indian willow beds, a flint knife, gourd bowls, etc.	4	2.50
More Experiments in Science. By Nelson F. Beeler and Franklyn M. Branley. 176 pp. '50. Crowell. This very practical book follows the same pattern set by the authors' previous books—*Experiments in Science* and *Experiments with Electricity*	5	2.50
In Woods and Fields. By Margaret Waring Buck. 96 pp. '50. Abingdon.	6	3.00

	Grade	Price
A book for beginning naturalists. It includes descriptions of several hundred birds, insects, other small animals, flowers, trees and shrubs. There are two hundred and thirty excellent black and white illustrations.		
Sea and Shore. By Clarence J. Hylander. 242 pp. '50. Macmillan This is an excellent reference book for anyone interested in the plants and animals found along seashores. The first chapter is about the sea as a home for plant life.	6	3.00

General Science

How Big is Big? By Herman and Nina Schneider. 40 pp. '50. William R. Scott A well illustrated book that will help children understand big and small objects. The authors say "you belong right in the middle, between an electron and a star."	1	1.75
The Size of It. By Ethel S. Berkley. 24 pp. '50. William R. Scott This is a first book about sizes. Little, big, long, tall, wide, narrow and short are the words described and illustrated.	1	1.00
Let's Look under the City. By Herman and Nina Schneider. 44 pp. William R. Scott This book explains and illustrates how people in a city get their water, electricity, gas and telephone service, and how city waste is disposed of.	3	1.50
The Story of Our Calendar. By Ruth Brindze. 64 pp. '49. Vanguard A well written and exceptionally well illustrated book that is easily understood. It answers such questions as—How were the months named? Why is there a leap year every fourth year? How did the sun, the moon, and the stars give us our calendar?	4	2.50
Worlds in the Sky. By Carroll Lane Fenton and Mildred Adams Fenton. 96 pp. '50. Day A simple, factual book on astronomy that is well illustrated. Includes the earth and other planets, sun and other stars, moon, comets, meteors, meteorites, galaxies and constellations.	4	2.50
Everyday Machines and How They Work. By Herman Schneider. 192 pp. '50. Whittlesey This book explains the workings of all kinds of household machines. It is well illustrated with black and white line drawings.	5	2.50

Plants

Play with Trees. By Millicent E. Selsam. 64 pp. '50. Morrow This book has five chapters—1. How to Grow Your Own Trees. 2. Pipelines in the Tree. 3. How a Tree Grows. 4. How Trees are Different from Each Other. 5. Tree Flowers. Each Chapter contains many suggestions for children's activities. The book is well illustrated with line drawings.	4	2.00
What Wildflower Is It? By Anna Pistorius. 25 pp. '50. Wilcox This is the fourth in a series by the same author. The others are *What Bird Is It?*, *What Animal Is It?*, and *What Butterfly Is It?* Illustrations of 50 wildflowers. The text is too difficult for primary grades but the pictures can be used.	4	1.50

Miscellaneous

Here's Your Hobby. By Harry Zarchy. 233 pp. '50. Knopf This is a beginner's book about twelve popular hobbies: pho-	4	2.50

	Grade	Price
tography, fishing, ceramics, stamp collecting, home repair, archery, tropical fish, collecting butterflies and moths, sailing, collecting leaves, and painting.		
Famous Men of Medicine. By Caroline A. Chandler. 140 pp. '50. Dodd	6	2.50
The story of medicine told by means of short sketches of these men and women. Hippocrates, Galen, Rhazes, Avicenna, Vesalius, Paré, William Harvey, Edward Jenner, Elizabeth Blackwell, Rudolph Virchow, Louis Pasteur, Joseph Lister, William Osler, Walter Reed, Sigmund Freud, Harvey Cushing, Alice Hamilton and Hans Zinsser.		
The Voyage of the Luna-1. By David Craigie. 252 pp. '49. Messner	6	2.50
This is an imaginative story of a trip to the moon in a rocket ship. Jane and Martin Ridley are stowaways whose adventures make good recreational reading.		

PUBLISHERS AND THEIR ADDRESSES

Abingdon: Abingdon-Cokesbury Press, 810 Broadway, Nashville 2, Tenn.
Crowell: Thomas Y. Crowell Company, 432 Fourth Avenue, New York 16, N. Y.
Day: The John Day Company, 121 Sixth Avenue, New York 13, N. Y.
Dodd: Dodd, Mead and Company, Incorporated, 432 Fourth Avenue, New York 16, N. Y.
Dutton: E. P. Dutton and Company, Incorporated, 286–302 Fourth Avenue, New York 10, N. Y.
Harcourt: Harcourt, Brace and Company, 383 Madison Avenue, New York 17, N. Y.
Holiday: Holiday House, 8 West 13th Street, New York 11, N. Y.
Knopf: Alfred A. Knopf, Inc., 501 Madison Avenue, New York 22, N. Y.
Lippincott: J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa.
Macmillan: The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y.
Messner: Julian Messner, Inc., 8 West 40th Street, New York 18, N. Y.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, N. Y.
Putnam: G. P. Putnam's Sons, 2 West 45th Street, New York 19, N. Y.
William R. Scott: William R. Scott, Inc., 8 West 13th Street, New York 11, N. Y.
Vanguard: The Vanguard Press, 424 Madison Avenue, New York 17, N. Y.
Whittlesey: McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y.
Wilcox: Wilcox and Follett Company, 1255 S. Wabash Avenue, Chicago 5, Ill.

The Third Annual
CONFERENCE ON TEACHING MATHEMATICS, GRADES 1–12
will be held at
The University of Wisconsin
Madison
July 2–6, 1951

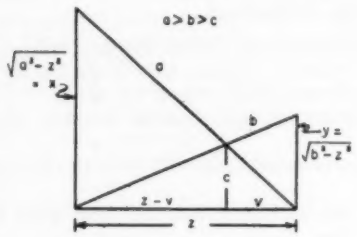
The program includes addresses and study groups on mathematics and on topics in the teaching of mathematics, curriculum study reports, a mathematics laboratory, and recreation. Housing will be available in university residence halls. If interested, please write to Professor J. R. Mayor, North Hall, Madison 6, Wisconsin for additional information and the complete program.

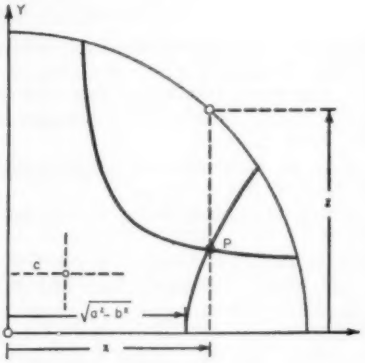
THE LADDER PROBLEM

ROBERT C. YATES
West Point, N. Y.

That hardy perennial, the "Ladder Problem," seems to be a national epidemic. Its solution lies hidden from the novice within a quartic equation, requiring more physical effort than mental. The following display offers some additional interest in a graphical solution involving hyperbolic arcs.

Two ladders of lengths a and b rest against two opposite walls and intersect c units above the floor as shown. Required: the width z of the room. Let distances x, y, v be as indicated.





From similar triangles: $\dfrac{z-v}{c}=\dfrac{z}{y}$; $\dfrac{v}{c}=\dfrac{z}{x}$.

Adding: $\dfrac{1}{x}+\dfrac{1}{y}=\dfrac{1}{c}$

But $x^2-y^2=a^2-b^2$ } x, y both positive only. (1)

These are two rectangular hyperbolas as shown. Their point of intersection P has coordinates x, y which are heights of the tops of the ladders from the floor.

Since

$$x^2+z^2=a^2,$$

a graphical solution for z may be obtained as the ordinate of the point on this circle whose abscissa is the common value of x for the hyperbolas.

For an algebraic solution, eliminate y in Equations (1) to obtain

$$\boxed{x^3(x-2c)=(a^2-b^2)(x-c)^2},$$

a quartic with one positive real root (found by successive substitution, by Horner's or Newton's method, etc.). The corresponding value of z may then be obtained from

$$z=\sqrt{a^2-x^2}.$$

For example, if $a=5$, $b=4$, $c=1$, the quartic is

$$x^3(x-2)=9(x-1)^2$$

with positive root

$$x=3.325$$

and

$$z=3.734,$$

approximately.

FIFTY YEARS OF CASMT

EDWARD BOS
Proviso Township High School, Maywood, Ill.

With apologies to Henry
And his justly proud descendants,
May I once again remind you
Of the coming of the CASMT,
Of the founding of the CASMT,
Of the naming of the CASMT?
How it grew and how it flourished,
How it came to choose the autumn,
Choose the glowing, waning autumn
As the time for holding meetings?

In the early 1900's
In a time dimly remembered,—
Long before the horseless carriage
With its duster costumed driver
Wearing goggles set in leather
Sent poor Dobbin to the pasture,
There to grieve and there to languish—
In the days of three dimensions,
In the time preceding Einstein;
Ere the tiny little atom
Had disclosed its mighty power—
In the days when good Kris Kringle
Still belonged to little children,
Still was dwelling at the North Pole,
Seemed content to drive his reindeer,
Came each year with sled well laden,
Filled with dominoes and checkers,
Popcorn balls and candied apples—

In the days when Christmas morning
Was a time of peace and quiet—
When behind each chair and sofa
Lurked no arméd desperado,
Later to be felled with "Bang! Bang!"
From a better armed Roy Rogers
Borne upon his faithful Trigger
Galloping at speed unmeasured,—
In the early 1900's
Came a band of physics teachers
In the blush and bloom of springtime
To the city of Chicago.

Here this band of eager teachers
Held an animated confab
Of the ways and means of physics,
Principles and laws of nature—
Of the laws of falling bodies,
Of the laws of gravitation,
Of the laws of conservation,
Of flotation and of friction,
Of rebound and of refraction,—
Laws of Ohm and Lenz and Pascal,
And the principle of Doppler,
Principle of Archimedes.

Fled were all their cares and worries,
And their eyes did twinkle, sparkle,
As they spoke of liquefaction,
Of the synchro-mesh transmission,
Of the Wheatstone bridge, of voltage,
Of reluctance and inductance,
Of capacitive reactance.

And this band of eager teachers
Sought to learn one from the other
How they might improve instruction
Sought for measures to determine
Values to be found in content—
Hoping thereby to choose wisely
What be taught and what deleted.

Pleaséd were they with their progress,
Glad to find a common purpose,
And they planned a second meeting
Of the same year, in Chicago.

Now they organized for service,
Chose a staff of five to guide them,—
And as president was chosen
C. H. Smith of Hyde Park High School
Of the city of Chicago—
Gave themselves a name, a title,
Called it an association,
The Central Association
(plus, of course) of Physics Teachers.

Once more that same year,—November,
C.A.P.T. met together,
This time also in Chicago.

In the meantime other teachers,
Teachers teaching mathematics,
Heard about the C.A.P.T.
Thought it was a big step forward
On the path of education.
And they drew up a petition
Begging that the C.A.P.T.
Take thought to extend its limits
To encompass all of science,
To embrace the mathematics—
Thus create a stronger weapon
In the cause of education.

Members of the C.A.P.T.
Gladly worked throughout the summer
Formulated plans, expanded
To include their science brethren
And their next of kin, the math men.
Then in nineteen three, in April,
In the city of Chicago,
C.A.P.T. metamorphosed
And emerged C.A.S.M.T.

Since then, once each year, in autumn,
In the last month but December,
At the time of the Thanksgiving
Come the members of the CASMT
To the chosen place of meeting.
From the lakes of Minnesota,
From the east beyond Ohio,
From Missouri and Kentucky,
From the western plains of Kansas,
Come the members of the CASMT.
There they all break bread together.
There they share their skills and technics,
Share their failures and successes,
Share their hopes, their aspirations.

Tempered is their conversation,
Tempered, too, their formal program
By the current social status
And the economic welfare
Of the peoples of the nations.

Through the teens of 1900
The association members
Struggled ever for acceptance
Of a program of instruction
Which would silence every critic—
Those who thought that math and science
Had been couched in style too formal,—
Was not meat meant for the masses,—
Only served researchers, medics,—
Held no values for the farmer,—
Was impractical for women.

In the gay and roaring twenties
The Association meetings
Emphasized the mathematics;
Everything was mathematics,

All the talk was mathematics,
Industry and mathematics,—
Medicine and mathematics,—
Sciences and mathematics
How to think—and mathematics.

But when came the dismal thirties—
And the little pigs were slaughtered—
And the fields of corn plowed under—
People paid for doing nothing—
Suddenly the members wakened,
Wakened with a sickened conscience,
Faced the fact that the resources
Of our great beloved country
Were misused, would be depleted.
Rous'ed were the men of science
Those who dealt with protoplasm,
And they stimulated thinking—
Built up attitudes most worthy
In the cause of conservation.
Through the dark and dismal thirties
Conservation was the watchword,
Conservation was the banner,
Every meeting made provision
For some mention of the problem.
Oft the main course of the menu—
Sometimes offered as a salad.

Each time war clouds lower darkly,
And the young men march to battle,
The association members
Seek to make their contribution
In the cause of truth and justice.

Each time some great law of nature
Is revealed to men of learning
It becomes the task of science
And of math men to interpret
To an eager worried people
Its import for daily living.

Thus with program ever changing,
With high purposes before them,
Every year the loyal members
Of the CASMT meet together.
Even now they are assembled,
If you listen you can hear them
Like the voice of many waters,
Like the voices of confusion
That rose once from Babel's tower.

See this group with happy faces,
Listen to their eager voices,
Follow them in conversation
As they speak of things that matter,
Speak of numbers, letters, figures,
Speak of quadratic equations,
Laugh together over tangents,
Polygons and arcs and segments,
Speak in riddles about quotients,

Logarithms, exponentials,
Vertices, interpolations
Squares and parallelopipeds.

Would you know what these are saying?
Would you hear their words of wisdom?
Would you learn the hidden secrets
Of the living protoplasm?
You must list in rapt attention
For their words are full of meaning,
Full of letters and of meaning.
Have you marked that they are talking
About things that last forever?
Of the Algae, the beginning,
In the phyllum Thallophyta,
Of the ending, the Ameba,
In the phyllum Protozoa,
Of the Algae and Ameba,
The beginning and the ending!

And their faces gleam with rapture
As they speak of cotyledons,
Speak of monocotyledons,
Speak of gay dicotyledons.
Who is there who has not trembled
At the thought of Amanita,
Amanita, deadly fungus?
Who has not beheld the beauty
Sensed the fragrance of the onion,
The wild onion, Allium Cernuum?
Faces too seem animated
At the mention of Euglena,
At the thought of Paramecium,
At remembrances of Rana.
Who is there who has not trembled
In the presence of Eunectes,
Of Eunectes, anaconda!
Who can not endure the beauty
Or the softness, warmth, and glamor,
Of a coat of mink, Mustela?

Let us not forget the chemists,
They who analyze synthetics,
Deal with elements and compounds
Speak a language unfamiliar
Save to those initiated.
For they speak of salts and acids,
Speak of alkaloids, hydroxides,
Valences, anions, cations,
Happy halogens and halides,
Moles and molecules, and atoms.

Since the early 1900's
To the present 1950
Every year a band of teachers
Meet together at Thanksgiving,
There to learn what's new in science,
There to ponder mathematics,
And returning to their classrooms
Find new hope to face the future.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2228, 2230, 2231. *Charles McCracken, Jr., University of Cincinnati.*

2229. *Ted Gray, Culver, Ind.*

2200. *Virginia Carey, Mt. Pleasant, Iowa.*

2227, 2228, 2231. *E. C. Rodway, Schumacher, Canada.*

2227. *Bill Bauman, Chicago, Illinois; John Stimel, Tarentum, Penn.*

2231. *V. C. Bailey, Evansville, Ind.*

2228, 2229, 2232. *C. W. Trigg, Los Angeles City College.*

2233. *Proposed by W. H. Cleveland, Meridian, Miss.*

There were three men John, James, and Henry and their wives Mary, Sue, and Ann, but not respectively. They went to market to buy hogs. Each person bought as many hogs as that person spent dollars per hog. John bought 23 hogs more than Sue; and James bought 11 more than Mary. Each man spent \$63 more than his wife. What is the name of each man's wife?

Solution by Joseph Kennedy, Greenfield, Ind.

Let a = number of hogs bought by a man
b = number of hogs bought by a woman

Since price and quantity are equal for any person, a man pays a^2 dollars and a woman b^2 dollars.

For a man and wife $a^2-b^2=\$63$ or $(a-b)(a+b)=\$63$.

The possible factors of 63 are: 1 and 63, 3 and 21, 7 and 9.

Therefore:

$$a-b=1,\ 3,\ 7$$

$$a+b=63, 21, 9$$

giving

$$a=32, 12, 8$$
$$b=31, 9, 1$$

respectively.

Since John bought 23 more than Sue he must have bought 32 and Sue 9, and since James bought 11 more than Mary he must have bought 12 and Mary 1, this leaves 8 for Henry and 31 for Ann. Therefore: John and Ann, James and Sue, and Henry and Mary are the married couples.

Solutions were also offered by: Max Beberman, Urbana, Ill.; C. W. Trigg, Los Angeles City College; B. B. Libby, San Francisco, California; Roby Fretwell, Canton, Mo.; Charles McCracken, Jr., University of Cincinnati; H. Brandt, Chicago, Ill.; William Johnson, Cleveland, Ohio; Gerald Doeden, Salem Ind.; proposer; and geometry class, McDonough, Ga.; Hazel S. Wilson, Annapolis, Md.; James F. Gray, Kirkwood, Mo.; Alva E. Lohse, Valparaiso, Ind.

2234. *Proposed by D. L. Foster, Florida A and M College.*

If x is real, prove that $(3x^2+2)/(x^2-2x-1)$ can have all values except such as lie between 2 and $-3/2$.

Solution by Margaret F. Willerding, St. Louis, Mo.

Let $y=(3x^2+2)/(x^2-2x-1)$. Since x is a real number, there will be values of y for every real value of x. When x is a complex number the function y will not be defined.

Since

$$y=(3x^2+2)/(x^2-2x-1),$$
$$x^2(3-y)+x(2y)+(2+y)=0$$

and

$$x=\frac{-2\pm\sqrt{2y^2-y-6}}{(3-y)^2}.$$

When $2y^2-y-6=(y-2)(2y-3)$ is less than zero, x will have complex values. This will occur when $-3/2<y<2$. Hence y will be defined for all values except those between $-3/2$ and 2.

Solutions were also offered by: Hugo Brandt, Chicago, Ill.; Norman Cumming; V. C. Bailey, Evansville, Ind.; James F. Gray, Kirkwood, Mo.; Alan Wayne Flushing, N. Y.; Max Beberman, Urbana, Ill.; Aaron Buchman, Buffalo, N. Y.; Charles McCracken, Jr., University of Cincinnati; B. B. Libby, San Francisco, Calif. and the proposer.

2235. A solution to this problem is not yet ready.—Editor.

2236. *Proposed by Felix John, Ammendale, Md.*

The angle formed by a line from A of triangle ABC, to S, the circumcenter and the altitude from A, is bisected by the bisector of angle A.

Solution by Betty I. Swanson, Chicago, Ill.

Let AD be the altitude, S the circumcenter, and AE the bisector of angle A. Draw AF, the diameter of circumcircle S. Draw FC.

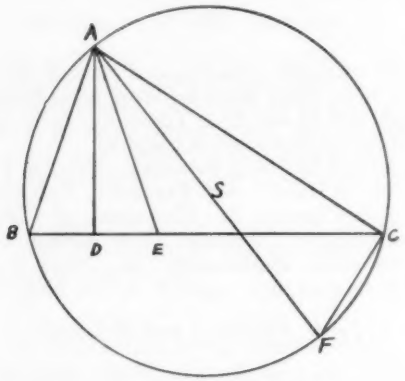
To prove: AE bisects angle DAS.

In right triangle BAD and FAC, angle B=angle F since they intercept the same arc. Thus angle BAD=angle FAC.

Since AE bisects angle A, angle BAE=angle EAC.

By the subtraction axiom, angle DAE = angle EAS, and angle DAS is bisected by AE.

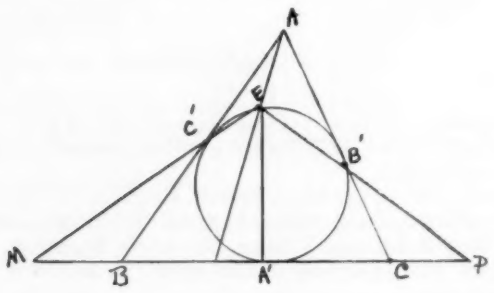
This problem appears as a theorem, page 53 of *College Geometry* by Altshiler-Court.



A solution was also offered by: David Freeman, Exeter, N. H.: G. E. Doedon, Salem, Ind.; Max Beberman, Urbana, Ill.; C. W. Trigg, Los Angeles City College; proposer; B. B. Libby, San Francisco; Norma Sleight, Winnetka, Ill.

2237. *Proposed by C. W. Trigg, Los Angeles City College.*

In triangle ABC, the points of contact of the incircle (center I) with the sides opposite A, B, C are A', B', C', respectively. $A'I$ meets the circle again at E. EC', AE, and EB' meet BC at M, N, and P, respectively. (a) Find the area of triangle MEP in terms of a, b, c. (b) Show that EN is a median of triangle MEP.



Solution by the Proposer

(a) CA' and CB' are tangent to the circle so CI is the perpendicular bisector of $A'B'$. Angle $A'B'E$ is inscribed in a semicircle, so PE is perpendicular to $A'B'$. Hence CI is parallel to PE and $CP = A'C = s-c$. Similarly, BI is parallel to ME and $MB = BA' = s-b$. Hence, triangles BIC and MEP are similar with a ratio of similitude of 1:2, so $MP = 2BC = 2a$. Now the area of triangle BIC is $ar/2$, so the area of triangle MEP is

$$4(ar/2) = 2ar = 2a\sqrt{s(s-a)(s-b)(s-c)}/s.$$

(b) It has been shown (Problem No. 121, *National Mathematics Magazine*, Vol. 11, p. 57, October 1936) that N is the point of contact of the excircle relative to A, so $BN = s-c$, then $MB+BN = 2s-b-c = a$. Hence EN is a median of triangle MEP.

A solution was also offered by Hugo Brandt, Chicago.

2238. *Proposed by Hazel Floyd, Nashville, Tenn.*

Find the sum of n terms of the series:

$$\tan^{-1}\frac{x}{1+1\cdot 2x^2}+\tan^{-1}\frac{x}{1+2\cdot 3x^2}+\cdots+\tan^{-1}\frac{x}{1+n(n+1)x^2}+\cdots.$$

Solution by Hugo Brandt, Chicago, Ill.

If $\tan\alpha=a$, $\tan\beta=b$, then

$$\tan(\alpha-\beta)=\frac{\tan\alpha-\tan\beta}{1+\tan\alpha\tan\beta}=\frac{a-b}{1+ab}$$

hence

$$\tan^{-1}\left(\frac{a-b}{1+ab}\right)=\alpha-\beta=\tan^{-1}a-\tan^{-1}b.$$

So,

$$\tan^{-1}\frac{x}{1+n(n+1)x^2}=\tan^{-1}\frac{(n+1)x-nx}{1+(n+1)x\cdot nx}=\tan^{-1}(n+1)x-\tan^{-1}nx$$

and the required sum,

$$S=(\tan^{-1}2x-\tan^{-1}x)+(\tan^{-1}3x-\tan^{-1}2x)+\cdots+(\tan^{-1}(n+1)x-\tan^{-1}nx).$$

Here all terms except two cancel, there remains

$$S=\tan^{-1}(n+1)x-\tan^{-1}x=\tan^{-1}\left\{\frac{nx}{1+(n+1)x^2}\right\}.$$

A solution was also offered by C. W. Trigg, Los Angeles City College; James F. Gray, Kirkwood, Mo.; Norman Anning, University of Michigan.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2227. *Clyde Lindner, Red Bank, N. J.*

2226. *Edward C. Bottemiller, Schenectady, N. J.*

2236. *Gordon Buck, Glencoe, Ill.; Norman Slight, Winnetka, Ill.; Barbara Howe, Winnetka, Ill.; Stephen L. Kanne, Glencoe, Ill.; Ralph L. Arnbeim, Jr.; Glencoe, Ill.; Eddie Seltzer, Winnetka, Ill.; Clyde Lindner, Red Bank, N. J.*

PROBLEMS FOR SOLUTION

2251. *Proposed by R. E. Horton, Los Angeles City College.*

Find the points on the curve $y^2=2x^3$ whose powers with respect to the circles $c_1: x^2+2x+y^2=0$ and $c_2: x^2-4x+y^2=0$ are in the ratio $p_1=2p_2$.

2252. *Proposed by Norman Anning, University of Michigan.*

The curves $\sqrt{x}=\sqrt{y}+1$, $\sqrt{x}+\sqrt{y}=1$ and $\sqrt{y}=\sqrt{x}+1$ are parts of the

parabola: $x^2-2xy+y^2-2x-2y+1=0$. Find points of intersection of the whole curves.

2253. *Proposed by Norman Anning, University of Michigan.*

The curves $\sqrt{y}=\sqrt{x}+1$ and $y=4\sqrt{x}$ are parts of two parabolas. What points, if any, do they have in common?

2254. *Proposed by V. C. Bailey, Evansville, Ind.*

Two corridors, widths 6 ft. and 8 ft. respectively intersect at right angles. If the inside corner is rounded so as to form a quadrant of a circle with radius 3 ft., find the length of the longest thin rod which can be moved in a horizontal position from one corridor to the other.

2255. *Proposed by Julius S. Miller, New Orleans.*

A man throws a stone with a velocity V_1 at an angle of elevation, A. In t seconds later, he throws a second stone with a velocity of V_2 at an angle of elevation, B. If the second stone hits the first, find t.

2256. *Proposed by Lanier Strong, Kirksville, Mo.*

Find by means of elementary geometry a point in a plane such that the sum of its distances from two fixed points on one side of the plane shall be constant.

BOOKS AND PAMPHLETS RECEIVED

GENERAL MATHEMATICS FOR THE SHOP, by Gilbert D. Nelson, *Chairman of the Mathematics Department at Lincoln High School, Cleveland, Ohio;* Frank C. Moore, *Director of Industrial Arts in the Cleveland Public Schools;* Carl Hamburger, *Supervisor of Industrial Arts in the Cleveland Public Schools;* and Philip Becker, *Principal of the William E. Grady Vocational High School, Brooklyn, New York.* Cloth. Pages viii+440. 14×23 cm. 1951. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $2.64.

ALGEBRA, MEANING AND MASTERY, BOOK TWO, by Daniel W. Snader, *University of Illinois.* Cloth. Pages v+500. 13×21.5 cm. 1950. The John C. Winston Company, 1010 Arch Street, Philadelphia 7, Pa. Price $2.60.

THEORY OF PROBABILITY, by M. E. Munroe, *Assistant Professor of Mathematics, University of Illinois.* Cloth. Pages viii+213. 14.5×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $4.50.

MICROBIOLOGY, GENERAL AND APPLIED, by William Bowen Sarles, *Professor of Agricultural Bacteriology;* William Carroll Frazier, *Professor of Agricultural Bacteriology;* Joe Bransford Wilson, *Associate Professor of Agricultural Bacteriology;* and Stanley Glenn Knight, *Assistant Professor of Agricultural Bacteriology, University of Wisconsin, Madison, Wis.* Cloth. Pages xi+493. 15×23.5 cm. 1951. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $4.50.

EXTENDING HORIZONS, HOW THE NEW REVELATIONS MAY PIERCE THE CURTAIN OF IGNORANCE, by Porter Sargent. Red silk cloth. 196 pages. 11.5×18 cm. Porter Sargent, 11 Beacon Street, Boston, Mass. Price $2.00.

RADIATION MONITORING IN ATOMIC DEFENSE, by Dwight E. Gray, *Chief, Navy Research Section, Library of Congress,* and John H. Martens, *Technical Information Service, Atomic Energy Commission.* Cloth. Pages iv+122. 13×20 cm.

1951. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.00.

GEOGRAPHY OF THE PACIFIC, by Otis W. Freeman, *Editor, Eastern Washington College of Education, Cheney, Washington.* Cloth. Pages xii+573. 14.5×23 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $10.00.

GEOGRAPHY IN THE TWENTIETH CENTURY, A STUDY OF GROWTH, FIELDS, TECHNIQUES, AIMS AND TRENDS, Edited by Griffith Taylor, *Head of the Department of Geography at Toronto University.* Cloth. Pages x+630. 13.5×21.5 cm. 1951. The Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $8.75.

CLOUD PHYSICS, by D. W. Perrie, *Meterologist, British Columbia Forest Service.* Cloth. Pages v+119+3 large tables+15 pages of cloud photographs. 16.5 ×25.5 cm. 1950. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

THE APACHE INDIANS, by Sonia Bleeker. Cloth. 157 pages. 12.5×19 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

STATE BIRDS AND FLOWERS, by Olive L. Earle. Cloth. 64 pages. 16.5×21 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

THE GREAT WHALES, by Herbert S. Zim. Cloth. 64 pages. 16.5×20.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, NewYork 16, N. Y. Price $2.00.

THE MAIN STREAM OF MATHEMATICS, by Edna E. Kramer. Cloth. Pages xii+321. 13.5×21 cm. 1951. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $5.00.

THE PRINCIPLES OF HEREDITY, Fourth Edition, by Laurence H. Snyder, Sc.D., *Dean of the Graduate College, The University of Oklahoma.* Cloth. Pages xi+515, 14×22.5 cm. 1951. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $4.75.

TEN RIVERS IN AMERICA'S FUTURE. The Report of the President's Water Resources Policy Commission, Morris L. Cooke, *Chairman.* Volume 2, 1950. Paper. Pages xx+801. 20×26 cm. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

STATISTICAL SUMMARY OF EDUCATION, 1947–48. Prepared by David T.Blose' *Specialist in Educational Statistics,* under the Direction of Emery M. Foster' *Head, Reports and Analysis Branch, Research and Statistical Service.* Paper. Pages vi+50. 15×23.5 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

INVENTORIES OF APPARATUS AND MATERIALS FOR TEACHING SCIENCE. Volume III, Technical Colleges, Part I, Veterinary Sciences. Paper. 98 pages. 15×24 cm. 1950. Published by United Nations Educational, Scientific and Cultural Organization, Imprimerie des Arts et Manufactures, Unesco, Paris.

DIRECTORY OF INTERNATIONAL SCIENTIFIC ORGANIZATIONS. Paper. Pages xiii+224. 15×24 cm. 1950. Published by United Nations Educational, Scientific and Cultural Organization, Imprimerie des Arts et Manufactures, Unesco, Paris.

THE NEW PHOTOSYNTHESIS, Midcentury Science Series, Number 5, by John

Edwin Coe, 2024 Sunnyside Avenue, Chicago 25, Illinois. Paper. 28 pages. 21.5×27.5 cm.

A REPORT ON AN ADMINISTRATIVE SURVEY OF THE U. S. OFFICE OF EDUCATION OF THE FEDERAL SECURITY AGENCY. Paper. 82 pages. 20.5×27 cm. October, 1950. 1313 East 60th Street, Chicago 37, Ill.

BOOK REVIEWS

CONTRIBUTIONS TO MATHEMATICAL STATISTICS, by R. A. Fisher, *Department of Genetics, University of Cambridge.* Cloth. 22×29 cm. 1950. John Wiley and Sons, Inc., New York, N. Y. Price $7.50.

This book brings to the student of statistics and mathematics 43 of the most important papers on statistical research. These papers were heretofor unavailable except in some of the largest centers of learning. The papers are concerned with the three main streams of Fisher's work: (a) contributions to the mathematical theory of statistics, (b) applications of statistical theory to agriculture and design of experiments, and (c) contributions to genetics.

The book also includes a most interesting biography of Professor Ronald Aylmer Fisher written by P. C. Mahalanobis. This biography was published in the December 1938 issue of *Sankhyā.*

The volume is a must for workers in the field, and should be found on the library shelves of all universities and colleges offering graduate work in statistics and mathematics.

KENNETH E. ANDERSON
University of Kansas

INTRODUCTION TO TESTING AND THE USE OF TESTS RESULTS, by Margaret Selover, Agatha Townsend, Robert Jacobs, and Arthur E. Traxler. Educational Records Bulletin, No. 55. Paper. Pages vii+107. 21½×28 cm. 1950. Educational Records Bureau, 21 Audubon Avenue, New York 32, N. Y.

This bulletin is an excellent nontechnical treatment of testing and the use of test results, for use primarily in independent schools; however, public schools with large numbers of college-bound students will find it most useful.

The guidance point of view including application to specific cases receives considerable emphasis. A number of forms and illustrations help to clarify the explanation.

The bulletin provides a practical handbook for schools contemplating the use of objective tests. Teachers of introductory classes in tests and measurements should find it an invaluable supplementary reference for prospective teachers. In addition, teachers in service will find the bulletin an excellent refresher on the simpler fundamentals of testing.

KENNETH E. ANDERSON

FUNDAMENTALS OF THE CALCULUS, by Donald E. Richmond, *Professor of Mathematics, Williams College.* First Edition. Cloth. Pages xi+233. 16×23.5 cm. 1950. McGraw-Hill Book Company, 330 West 42nd, New York 18, N. Y. Price $3.00.

This text would seem to be planned for a first year college student who probably has not presented College Algebra or Analytic Geometry as a prerequisite. The first chapter contains a more extensive than usual treatment of the real number system with special attention to rational and irrational numbers, inequalities, and infinite sequences of numbers. The second chapter contains some material (for example: synthetic division, and upper bounds for roots of an equation) usually found in a course for College Algebra; chapter three includes material on the slope of a line; chapter six treats complex numbers and some elementary trigonometry; chapter seven covers some analytic geometry of the

conics. Calculus concepts are used for a considerable portion of the discussion of such topics as are traditionally covered in a more elementary course.

Integration is introduced essentially half way through the text, before treating transcendental functions. The author's approach is somewhat different in that he develops some of the properties of e^x from those on $\ln x$, rather than the reverse.

There is no work on partial derivatives or multiple integration, and infinit series are mentioned only briefly in connection with other topics. There is no use made of any derivatives higher than the second. The number of problems seems small; several of these are extensions of the text theory and are often needed for further text development.

The book is probably not extensive enough for a course following analytic geometry. It may serve well as a first course, particularly in the case where the student may go no farther in mathematics.

CECIL B. READ
University of Wichita

ANALYTIC GEOMETRY, by Raymond D. Douglass, Ph.D., Sc.D., *Professor of Mathematics, Massachusetts Institute of Technology,* and Samuel D. Zeldin, Ph.D., *Associate Professor of Mathematics, Massachusetts Institute of Technology.* First Edition. Cloth. Pages ix+216. 16×23.5 cm. McGraw-Hill Book Company, New York, N. Y. 1950. Price $2.75.

This book is a text planned for the traditional course in analytic geometry, neither extremely brief nor an exhaustive treatise. It covers the straight line and the conic sections, translation and rotation of axes, polar coordinates, parametric representation, transcendental curves, and an introduction to solid analytic geometry, but omits such topics as diameters, poles and polars, empirical equations, systems of curves.

The reviewer found unusual, but not objectionable, treatment of the distance from a point to a straight line (the normal form of the equation of a straight line is not so named, and used only in the distance problem). The authors select to give without proof the relations between the coefficients of the general second degree equation which enable one to determine which specific conic is represented by a given equation—since proofs are readily available, there seems no particular reason to include a proof in this text.

Certain features seem subject to some criticism, for example, there are several poorly drawn figures (for example, figures 47, 78, 82, 85, 95). It would seem preferable to state that a line perpendicular to the x-axis has no slope rather than that its slope is infinite. A related statement to the effect that the equation $m_2-m_1/1+m_1m_2=$ is satisfied when $1+m_1m_2=0$ makes one wonder just what is implied by "satisfied." The discussion of finding the angle between two lines (both in the plane and in the space treatment) fails to specify which angle is meant. On page 87, the student may wonder just how a plane passing through the vertex of a right circular cone can produce two parallel lines; on page 172 one might question why the surface in question is called the elliptic, rather than the hyperbolic, cone.

There are certain features which seem to offer distinct contributions. The discussion of symmetry and of asymptotes in the material on sketching curves seems to the reviewer superior to that usually encountered. The authors are careful to point out that an equation obtained by eliminating the parameter from given parametric equations may contain points not on the locus defined by the given equations—a point rarely mentioned in most texts.

There seems to be a reasonably adequate supply of problems, with answers provided. A set of review exercises appears at the end of each chapter. Eleven pages of numerical tables contain all the material needed for solution of the examples.

CECIL B. READ

ELEMENTS OF MATHEMATICAL ANALYSIS, by Samuel E. Urner, *Los Angeles City College*, and William B. Orange, *Late of Los Angeles City College*. Cloth. Pages xi+562. 16×23.5 cm. Ginn and Company, Boston 17, Mass. 1950. Price $4.00.

Books with titles similar to this one may vary widely in content—on the one hand a brief treatment planned for a one semester course for students who will take no additional mathematics; at the other extreme texts which cover thoroughly material through the calculus or even differential equations. This text tends toward the second extreme. Assuming a background of plane geometry, intermediate algebra, and trigonometry it covers rather completely most of the traditional material of trigonometry (rather rapidly emphasizing the analytic side) analytic geometry, and differential and integral calculus up to, but not including such topics as infinite series, partial differentiation, and multiple integration. The preface states that there is sufficient material for a two year, three hour course. Even with this time, some teachers would wish to omit certain topics.

There is an ample supply of problems, in general answers are provided for the odd numbered exercises. Problems which the authors consider more difficult are starred. No mathematical tables are included.

Certain points may be mentioned as unusual, for example the teacher accustomed to a traditional sequence may be shocked to find the first formal treatment of analytic geometry on page 155, after both differentiation and integration have been treated at some length. He may wonder why the general formula for the area of a triangle in terms of the coordinates of its vertices was not developed The use of the plane geometry theorem about an angle inscribed in a semicircle, together with the analytic geometry equation of a circle given an unusual approach to the relationship between the slopes of perpendicular lines. Conics are introduced with the focus-directrix definition, and the focal radii relationships brought in later as somewhat of a minor development. The trigonometric discussion tends to stress the unit circle definitions. The discussion of determinants, definitely pointed out as incomplete, is somewhat unique in that there is no use of the concept of inversions in attempting to define the general nth order determinant.

A few points seemed to the reviewer to be below the general high standard of the book. On page 15 there is in one place a definition of a tangent as the limiting position of a secant as points of intersection approach each other; at another place the definition is the limiting position of a line PQ when Q approaches P (in the first case, without one point fixed one wonders if a limiting position exists, in the second case there is nothing to require that either P or Q be on the curve). On page 25 it is shown that for $y=mx+b$, the average rate of change of y between $x=x_1$ and $x=x_2$ is constant, followed by the statement, "This average rate being *constant*, its limit, as x_2 approaches x_1, is m." Is it not the fact that this average rate is independent of x_2 and x_1 that makes its limit m? Some teachers may feel that the discussion of logarithmic and exponential functions is not rigorous enough—quite possibly it is satisfactory for a first treatment. It is not mentioned that the elimination of the parameter from given equations may yield an equation which contains points not on the locus defined by the given equations. In the treatment of Newton's method, the first approximation is taken "near" the root—no mention being made that the method may fail even with a "near" approximation. The proof of an identity on page 424, left to the student, may prove quite tricky.

It should not be implied that the points mentioned are important enough to make the book worthless. Quite to the contrary, in many respects the book appeals to the reviewer as outstanding. On page 21, the authors mention a point which has puzzled many a beginner—we may have a maximum point at a point where the value of the function is ***numerically*** less than anywhere else in the neighborhood. The proof of the formula for the derivative of x^n which utilizes mathematical induction but does not require the binomial theorem will appeal to many instructors (and provides a basis for an unusual proof of the

binomial theorem, given in the appendix). In the discussion of pencils of curves, it is proved that the pencil $f(x, y)+k\cdot g(x, y)=0$ cannot intersect either $f=0$ or $g=0$ except where they intersect each other, a fact rarely pointed out. The discussion of the problems arising in attempting to find the derivative of a double valued function; the treatment of conics with foci on the y-axis; the discussion of the method of using a table of natural logarithms; the discussion on page 449 of the selection of the proper branch of the inverse sine function—all these are illustrations of the care taken to help the student over spots where he may encounter difficulty and to encourage critical thinking. (Many an instructor will find a reading of these sections extremely informative). The development of the normal form of the equation of a straight line by starting with the polar coordinate equation seems to offer distinct advantages.

In addition to the main body of the text, there is an appendix of some 28 pages, ranging from a listing of formulas from earlier courses to a discussion of topics in greater detail than seemed feasible when first introduced (an example is the somewhat detailed treatment of limits, starting with the classical epsilon-delta definition).

For any instructor interested in a course of this character, this text must by all means be considered as outstanding; for supplementary material both as to theory and applications, written at a level which either student or teacher can readily follow, the book should be considered as an addition to private or school library.

CECIL B. READ

PLANE AND SPHERICAL TRIGONOMETRY, by H. L. Rietz, *Late Professor of Mathematics*, J. F. Reilly, *Late Professor of Mathematics*, and Roscoe Woods, *Associate Professor of Mathematics, University of Iowa*. Cloth. Pages xiii+205+72. $14\frac{1}{2}\times 21$ cm. 1950. Macmillan Company. $2.75.

Dr. Woods has skillfully taken advantage of the classroom experiences encountered in the 14 years of use to improve upon an already excellent book. This third edition embodies the major features of the previous books; however, much of the problem material has been changed, more problems have been added, and the grading of the problems rearranged. The usual material is covered with a choice of carrying the course through spherical trigonometry or stopping it with inverse trigonometric functions. Answers are provided to the odd numbered exercises. The text contains well over 1000 exercises ranging from simple to very difficult. The drawings are well done and labeled for clarity.

Chapter I introduces the functions and relates them to similar triangles. The chapter closes with a set of excellent questions to test the student's ability to analyze variable relationships. This feature might well have been carried throughout the text. There are four pages on significant figures and the nature of measurement but the text specifically states all figures used in it will be considered exact. To the reviewer this seems to be a decided weakness. New terms are well defined in light of previous concepts while rigor is maintained. The case of functions where zero is included in the denominator such as Cotangent $0°$ is developed in a simple but excellent manner. The entire text is carefully written with many small but enlightening distinctions being pointed out to the student. Logarithms to base 10 are included, as is radian measure, trigonometric equations and spherical trigonometry. The spherical work includes Napier's rules, functions for spherical triangles, solution of spherical triangles, the sin law, cosine law, and half-angle formulas for spherical figures. These are applied to astronomy and great circle distances. A five place log table, four place trigonometric function table and a five place log trigonometric function table are included.

This book will no doubt continue to prove its usefulness, as have the two previous editions.

PHILIP PEAK
Indiana University

PLANE GEOMETRY, by William G. Shute, William W. Shirk and George F. Porter, *Instructors of Mathematics, The Choate School, Wallingford, Connecticut.* Cloth. viii+406 cm. 1949. American Book Company.

This text tends to be a self-teaching geometry book in that the proofs of theorems and more difficult corollaries are worked out in full. They are well done in standard form with a short analysis preceding the formal demonstration. There are many original exercises. The general plan of the book is to present the definition then expand the concept. Everyday examples of geometric principles are numerous. Chapter I is introduced by a matching test, for example:

The sharp end of a needle— Point

Throughout the text historical notes are introduced and used. The relation of geometry to everyday logical reasoning is stressed, with emphasis on the difference between logic and intuition. There are lists of exercises which are labeled as applications of certain theorems, usually those theorems just preceding the set. In theorems and problems where a figure is given the unknown part is often labeled with a question mark.

Most chapters are introduced with a full page picture which in most cases is very appropriate to the content material of the course. There are many figures and they are all well drawn and well labeled. Each chapter includes test questions and practice exercises. The material covered is that of most plane geometry texts and the arrangement is similar. The chapters, however, have been made shorter by separating into concurrency, locus construction, the broad topic of locus. There is a six-page chapter of review examinations, a ten-page set of additional exercises, a table of trigonometric functions and a summary of important formulas with page references. This text would be an excellent one for a class concerned with original problems. If the purpose is to pursue some of the classical theorems the student will be handicapped by the completed proof in the text. It is a text which is also easily adapted to home study. This is not just another text but would fill a specific need.

PHILIP PEAK

A SECOND COURSE IN ALGEBRA, by N. J. Lennes, and J. W. Maucker, formerly *Dean of School of Education, Montana State University.* Cloth. Pages xvi+521. Macmillan Company, New York, 1950.

This is the second revision of a text first written by N. J. Lennes in 1935 and first revised in 1943. This second revision involves very few changes in content, and little change in organization. These changes are limited to introductory statements, pictures, price quotations in problems, order of chapter summaries and reviews, along with the introduction of the "hit the target" teaching device. Following the first paragraph of Chapter 16 no changes have been made. The material covered is complete, including algebra used in geometry, series, probability and determinants. There is sufficient material for a full second year course. The "hit the target" technique is an introduction to each chapter with a statement of what the chapter hopes to accomplish along with some helps on how this might be done. The chapter then closes with some question to determine if the target was hit.

The pictures are well done and appropriate to the content. The problems are arranged in ability groups—A, B, and C. There is an abundance of problem material with a sufficient percentage of verbal problems. Chapter 14 "Algebra Used in Plane Geometry" is well done and a beneficial part of any algebra book. The historical sketches at the close of the text are a valuable aid in teaching. There is a four place logarithm table, a logarithm trigonometric table, a natural function table and a table of powers and roots. This text is well presented, has a good appearance and for the school that wishes to have a complete course presented in the standard manner, this text should be given some consideration.

PHILIP PEAK

THE HEBREW IMPACT ON WESTERN CIVILIZATION, Edited by Dagobert D. Runes, *Doctor of Philosophy of the University of Vienna.* Cloth Pages xiv+922. 13×21.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.

This tome of nearly one thousand pages is a symposium whose title defines its intent. (Unfortunately, I must report that in my judgment the ambition was not as adequately fulfilled as it might have been.) It is intended to deal with the creative and cultural influence of the Jew on modern civilization. Seventeen authors have collaborated, all of whom are not Jews. The thesis in brief is this: what are the contributions of the Jews?

First to the Dedication: "To the sainted memory of the six million children of Israel who were put to the axe by the German nation because they were of the same blood as Jesus Christ." This is a moving commentary and perhaps not inappropriate.

Concerning the Preface: The Editor says that "this book is a book of propaganda." This is all right since its mission is "to bring intelligence about the work and life of the Hebrews *pro paganis.*" (Italics mine.) Further: "The *pagans* (italics again mine) for whom this volume is intended are the many, many people in whose midst the Hebrews have lived for thousands of years." This reference to Christian pagans or better, to pagan Christians, is not the wisest reference, literary or otherwise. As propaganda the Editor has already done the volume injury.

The rest of the Preface states the over-all case for the Jew but in a language that sounds bitter and aggressive. In my judgment the case needs no such polemic. A more passive recitation with intellectual temper would be less irritating. "This book will show *to those who wish to learn* that the Jew . . . ." (Italics again mine.) But "perhaps the world needs to know more about the Jews" and this volume intends to tell about them.

The body of the book is composed of eighteen essays, each by a different author. Some of these are very readable. Some are very badly done. Many are just stuffed with inconsequential facts and do not even come up to an elementary encyclopedic article. In many there appear long lists of names and titles of books which "exposition" can hardly appeal to too many readers. Worse still, the material in many places does not read smoothly or fluently, and indeed, the grammar and syntax in a number of instances are not the best. But these matters will, we hope, be put aright in another edition, for we must recognize the very formidable labour in putting this book together for the first time.

Throughout written history every people having a national complexion have boasted of their own. It is not inappropriate, therefore, that Jews do this for Jews. Indeed, the Jew has been thought of only as a money-lender and usurer at that, or as a shopkeeper. Here his achievements as farmer, soldier, explorer, scientist, musician, artist, man of letters, philosopher, jurist, scholar, are recited.

Although it might appear ridiculous for a reviewer of such an encyclopedic volume to mention "omissions" I think that both Albert Einstein and Karl Marx deserve much more attention. Indeed, one wonders why *they* are not contributors? (Unus tenetur se ipsum accusare!)

Withal the book is eminently worth reading. It will be enlightening to the well-informed and certainly to the man in the street. It may not, however, reach too many at ten dollars.

JULIUS SUMNER MILLER
Dillard University
New Orleans, Louisiana

SOURCEBOOK OF ATOMIC ENERGY, by Samuel Glasstone, *Consultant, U. S. Atomic Energy Commission.* Cloth. Pages 546. 1950. D. Van Nostrand Company, New York, N. Y. Price $2.90. Prepared under the direction of the Technical Information Service, U. S. Atomic Energy Commission.

As indicated in the foreword by Mr. Gordon Dean, Chairman of the United States Atomic Energy Commission, this book was written by Dr. Glasstone at the request of the Commission and was screened, for security, by the Office of Classification of the Commission and reviewed for technical accuracy by several scientists associated with the national atomic energy program.

Originally requested of the Atomic Energy Commission for author use by the American Textbook Publishers Institute, this volume exceeds all reasonable expectations of authors, scientists, teachers, and literate laymen alike who have wished for an authoritative, comprehensive, and usable sourcebook covering the broad scope of atomic energy and related phenomena.

It is impossible to make comparative evaluations with other single references for the simple reason that no other book of comparable coverage combined with needed technical detail is on the market. It is much as if one were to review the first dictionary of the English language. One must use absolute standards for analysis. These are the criteria of comprehensiveness, specificity of detail, accuracy, and usability. The book is almost incredibly good on the first two counts, it would appear to be satisfactory on the second, and is reasonably so on the last.

Space does not permit an adequate documentation of this judgment. A few examples must suffice. The comprehensiveness of the book is impressive. Approximately two thirds of the book covers ground not directly treated in the Smyth report. This material ranges from cogent and insightful accounts of the earliest theories of the nature of matter and atomic structure, through the development of our knowledge of energy and matter, through the accelerated search connected with the Manhattan project, down to the present work being done with reactors, radioisotopes, betatrons and so forth, and on cosmic rays, artificial mesons, radiation effects and health physics. The economics of atomic power are more alluded to than developed, but with the Cowles Commission report now available in book form from the Princeton University Press this omission is not serious. Nonetheless one would wish for somewhat more detailed treatment than provided by the three pages devoted to the subject. This particularly when, after certain cautionary statements, this brief section ends with the promising statement:

> Nevertheless, it is probably safe to state that ultimately the cost of electricity obtained from fission energy will not differ outstandingly, in one direction or the other, from that derived from other sources of power. (Page 409, par. 14.136.)

Thermonuclear reactions and fusion of light nuclei; mu-mesons; radio-chemical asepsis; possible hereditary effects of radiation in man; transmutation phenomena; radioactive disintegration series—what are you interested in; it almost certainly is in this book.

For a book to combine such comprehensiveness with significant and detailed treatment of each major topic considered is truly remarkable. If you have become satiated with "popularizations" and want historical, theoretical, and experimental detail that will give you both perspective and knowledge—and if you haven't the time or resources to peruse hundreds of basic references, this book will be a real delight. The analysis provided of our growing knowledge in the field is liberally supported by quotations from the writings of the great and those who, not so well known, yet contributed their important and even essential parts. Graphs, half tones, and diagrams clarify the account. Hundreds of fundamental equations are given with their derivations. Both theory and experimental verification or refutation are liberally provided. This book provides detailed information and leaves very little on the level of undocumented or unsupported statement.

The reviewer has a fair library of references in atomic energy. He checked in the present book on a dozen or so matters on which he was unclear and on which he had been unable to secure data sufficiently detailed or elaborated to satisfy him. Without a single exception this book provided the detail he had found

wanting in other references. True, extensive library research could have given him the answers. But here, in one book, were what he needed.

The present reviewer is not competent to attest to the accuracy of all this detail. The criterion of accuracy seems to have been reasonably satisfied through review, in manuscript form, by several nuclear scientists. Some errors are bound to have occurred in a book of this complexity, but they are likely to be insignificant within the purposes of general education.

The book can profitably be used in two ways. It can be turned to for specific answers to specific questions, and the searcher will be rewarded. Or it can be studied as a volume presenting a cogent and developmental account of the present status of our knowledge. It is prepared as a sourcebook but it is far more than an encyclopaedia. It has a literary and an integral quality missing in the latter sorts of references.

Both of these uses are admirably suited to the needs of teachers. Any teacher who has developed units in atomic energy or who has taught on the subject in connection with the necessarily limited accounts given by high school texts has experienced the need of a handy reference to which he or his students could turn for further elaboration, confirmation, the filling in of detail, or for the settling of moot questions. The reviewer recently received a letter from a high school teacher raising questions regarding certain alleged discrepancies and errors in a high school text on atomic energy he was considering for possible classroom use. Each of his three questions could have been answered by reference to this volume. One of his questions, for example, referred to discrepancies in masses ascribed to certain elements in the text and in the last international periodic chart. The teacher's training had doubtless been in chemistry and he was apparently unaware that physicists and chemists use slightly different mass numbers in their work. The text, in referring to the loss of mass in the alpha particle as compared to its constituent nucleons, gave the mass of the helium nucleus as 4.0028, as compared with the 4.0331 mass of the constituents. This figure for the mass of helium is at variance, of course, with the mass as listed on periodic charts. On page 194, paragraphs 8.59 and 8.60 of Glasstone's book the teacher could have found the reason for this discrepancy well stated and clarified and could have found that, and why, the isotopic weights obtained through the use of the mass spectrograph must be divided by 1.00027 in order for the physical mass to conform to the chemical atomic weight scale. The beauty of the book is that an intelligent high school student can understand such sections as this and presumably gain stature in both chemical and physical understanding.

The limitation in usuability in the book for teachers is that the index, while cross-referenced, is inadequate in terms of the range of specific questions that arise in classroom discussions. This is a serious limitation and it is to be hoped that the next edition will place the index on par with the text in this particular. Perhaps only an experienced teacher working with a trained indexer could do the job for the problem is often that of word choice and of interest vectors.

A caution is perhaps in order relative to the use of the book as a developmental account. It requires some background literacy in the field for it to be wholly rewarding. This is not to say that one must be technically trained in nuclear physics. It is simply to say that the very detail which makes the volume excellent will be a deterrent to understanding unless the reader has first gained some general perspective on the field. If the teacher—or the gifted student, for that matter—has first studied such a volume as Selig Hecht's admirable ***Exploring the Atom***, or has in other ways, developed a general understanding of the history of atomic research and theory and the present status of our knowledge and endeavors he will find this volume rewarding and even exciting reading from page one to the completion of the book. The fact that he may occasionally be thrown by equations and their derivations or by relatively difficult theoretical constructs will not seriously detract from his enjoyment and profit in studying this extraordinary book.

The reviewer considers this book to be a "must" in every science teacher's

library. At the cost of $2.90 *Sourcebook on Atomic Energy* should be snapped up as the best book bargain buy for science teachers since *America's Needs and Resources* hit the bookstores.

R. WILL BURNETT
University of Illinois

SCIENCE FOR BETTER LIVING, by Paul F. Brandwein, *Chairman of the Science Department, Forest Hills High School, New York City Instructor, Teachers College, Columbia University;* Leland G. Hollingworth, *Director of Science, Brookline Public Schools, Brookline, Massachusetts;* Alfred D. Beck, *Science Supervisor, Junior High School Division, Board of Education, New York City;* and Anna E. Burgess, *Directing Principal, Formerly Supervisor of Elementary Science, Board of Education, Cleveland, Ohio.* Cloth. Pages xii+643. 16×24 cm. 1950. Harcourt, Brace and Company, Inc., 383 Madison Avenue, New York 17, N. Y. Price $3.28.

The outstanding feature of this general science text book is its up-to-date nature in the fields of science. There is a general sense of correlation of subject matter throughout the text, thus giving the student the basic feeling of the essential similarities between the various sciences.

Of the eight basic units the first deals with man, giving the student an introduction into psychology and anthropology, as well as human biology. There are also units on astronomy, weather, chemistry, physics, communication, biology, and health and safety. Within these units the text brings the student to the most recent developments in the particular field of science. Such things as atomic energy, television, radar, jet propulsion and other recent developments are discussed adequately for this level.

The book is written in an interesting manner, almost a story book type of narration. Another of the strong points is the many fine diagrams and pictures which arouse further interest on the part of the student, and are well related to the text. There are many fine experiments which are well correlated to the work. The double column type of page is an advantage for quicker, easier reading.

The authors claim that except for a technical vocabulary of 550 words the remainder of the book is within the comprehension of 8th and 9th graders. Although this is an extremely fine book, I believe it could only be used successfully with intelligent 9th graders. This book has many advantages for the ambitious student, having book lists and additional experiments following the chapters. This book is definitely written with the interests of the pupil in mind.

BLANCHE J. BERLAND
Tilden Technical High School
Chicago, Illinois

QUAKERS IN SCIENCE AND INDUSTRY, by Arthur Raistrick, M.Sc., Ph.D., *Lecturer in Applied Geology (Engineering and Mining) at King's College, Durham University.* Cloth. 361 pages. 13×21.5 cm. 1950. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

This is a book which will not only be of interest to every member of the Friends Society but to every student of scientific development in the British Isles and the United States during the 17th and 18th centuries. It discusses the expansion of trade in Great Britain and the gradual change from an agricultural country to one of commerce, manufacturing, and mining, where the study of finance became a necessity; where banks became prominent and influential; where scientific development was encouraged and fostered; where cities grew rapidly; and where government became centralized and extended its influence and control in all industry, business, and professions. In most of this the Quakers took a prominent part. They were largely from a yoeman and artisan classes rather than from either the landed gentry or the laborers. Education was a part of the Quaker theory from the start. Apprentices learned the business of their employers and

were given a start in business when their apprenticeship ended. The development of the iron industries, mining, and transportation are treated in detail. A chapter is given to the time problem and to the manufacture and repair of clocks. Basic science, with botany in the lead, is represented by such men as Peter Collinson and John Bartram. Other Quaker scientists of this time whose works and investigations are discussed include James Logan, a secretary to William Penn, but a botanist of note and a student of other branches of science; John Fothergill famous as a physician and a student of natural science; John C. Lettsom, another famous man of medicine of his time, who was also a great gardener and a student and writer on other branches of science; William Curtis, the author of *Flora Londinensis* and many other books and articles on agricultural and botanical subjects; William Phillips, the great geologist of his day.

This book is unusual in many ways, and is excellent reading for anyone interested in the development of science.

G. W. W.

FIRST BOOK OF CHEMISTRY FOR BOYS AND GIRLS, by Alfred Morgan. Illustrated by Bradford Babbitt and Terry Smith. Cloth. Pages xii+179. 13.5×21 cm. 1950. Charles Scribner's Sons, New York. Price $2.75.

With fifty-three of the pages of this book featuring informal illustrations, the author has little difficulty in conveying the idea of fun and interest being derived from chemistry as a hobby. The eight chapters of the book are devoted to instructions for doing entertaining exercises with such chemicals as may be found in the ordinary pantry and kitchen. The reader is advised that there are only five materials to be obtained elsewhere. These, litmus paper, filter papers, phenolphthalein solution, a glass tube and a funnel, he is told, are available at the drug store.

Boys and girls of early high school age will find the exercises interesting club activities, particularly when the job at hand is to prepare demonstrations for "open house" or for the occasion when the counselors ask the science department to exhibit something of the work of the school for incoming freshmen.

While some elementary processes and facts of chemistry are enthusiastically presented, the author has avoided asking any questions. What is ahead in chemistry is left, possibly, to spontaneous imagination of the reader. The succession of exercises with chemical actions may cause the reader to observe his environment with considerable attention on the chemical aspects. The five pages of index add to the usefulness of the publication.

ALLEN F. MEYER
Detroit, Michigan

CHEMISTRY VISUALIZED AND APPLIED, by Armand Joseph Courchaine. Edited by M. Cordelia Cowan. Drawings by Richard Albany. Cloth. Pages xvi+687. 13.5×21 cm. 1950. G. P. Putnam's Sons, New York. Price $5.50.

Being an outgrowth of teaching experience in a specialized field, this book is immediately different from the usual introductory textbook in chemistry. Designed primarily for students of nursing, or students contemplating or preparing for a career relating to health and disease, the subject of chemistry is presented with detailed reference to applications and interpretations in fields of surgery, medicine, physiology, pathology, pharmacology, microbiology, nutrition, nursing, and dentistry. Recognition of some industrial and everyday applications is made.

Illustrations, such as would appear in teaching lectures, appear with psychological rather than logical regard for the points under consideration. Each chapter is introduced with a substantial number of introductory questions and ends with an equally appropriate number of test questions. Practical suggestions addressed to instructors and to students, preceding chapter I, indicate consider-

able thought and planning for the teacher and for the student. While the author has made a sincere effort to present a course in such a way that the text can be used by students who have had no previous preparation in chemistry and in such a way that the work can be covered in sixty hours of class meetings, or at most ninety hours of class meetings, the caliber of students must be superior to cover the course in the longer period of time.

Part One is devoted to Fundamentals and Applications of Inorganic Chemistry, Part Two is devoted to Fundamentals and Applications of Organic Chemistry, and Part Three is entitled Introduction to Biological Chemistry. Physiological considerations appear in all three parts. At the outset, the author states that it is extremely important that fundamental terms, laws and theories be carefully defined, explained and understood. From there on, technical expressions, both chemical and non-chemical, appear so frequently that the need for systematic study can not long be ignored.

Recognition of steps in scientific method leading to conclusion is either presumed or ignored. The present writer rather expected to find something of this nature early in the book, in view of the fact that previous experience in such basic science is not prescribed for students using the book. Otherwise, within the field of specialization, the book is up to date. The treatment of atomic structure and relationships between matter and energy, together with striking applications, among other items, bear out this observation, as do the treatments of hormone chemistry, vitamins, antibiotics, ionization, and electrochemistry. Attention of the student is focused on some current problems under investigation with the idea of becoming alerted to observe the changing status of chemical knowledge.

The Machol Edge Index is a special feature of the physical attractiveness of the book.

ALLEN F. MEYER

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

ELEMENTARY SCIENCE SECTION

The annual meeting of the Elementary Science Section of the Central Association of Science and Mathematics Teachers was called to order Friday, November 24, 1950 at 10:40 A.M. by the chairman, Miss Viola Henrikson. The minutes of the last meeting were read and approved. Miss Henrikson announced the names of the nominating committee composed of Muriel Buschlein, chairman, Leila M. Whitney and Sister M. Innocent, C. R.

Miss Henrikson opened the program with a short introduction on the general theme of the meeting "Five Senses—Let's Use Them." She explained that most learning reaches the mind through the visual and auditory channels and that the program for today was devised to demonstrate how several audio-visual methods could be applied to science teaching.

Mr. Murl Salisbury of Evanston High School was the first participant on the program. He demonstrated many varied uses of the opaque projector and explained the need it meets in giving recognition to students.

Miss Louise M. Jones of the LaGrange Public Schools, next used a wire recording to illustrate a unit on astronomy titled "A Trip to the Moon." She explained the many implications of this device in motivating children.

Mr. Walter Johnson of the Society for Visual Education then showed how a Takistiscope could be used effectively as a time saving device for pupil and teacher and the unique feature this instrument has of pin pointing a single object on a slide.

Mr. Leon Ericson of the Society for Visual Education exhibited by means of projection a variety of micro-slides and outlined their use as a teaching device.

Mr. Eric Bender of the Row, Peterson Co. presented a film strip and explained its use in terms of preparation and instruction.

Mr. John Sternig of Glencoe Public Schools, gave a most interesting and informative demonstration on the use of home equipment in science teaching with models, charts, tables and pictorial displays.

Mr. Joseph Dickman of the Encyclopaedia Britannica Films presented a film on "Gray Squirrel" and explained how, for the first time, textbooks have been made to follow the content of motion pictures and that by this method, children have made phenomenal progress in reading.

The chairman of the nominating committee presented the names of the following persons who were elected for the coming year:

Chairman:	Mr. Albert Piltz Roosevelt Elementary School Detroit, Michigan
Vice Chairman:	Miss Ella Nichols City Schools Alma, Michigan
Secretary:	Miss Louise M. Jones Congress Park Schools LaGrange, Illinois

ALBERT PILTZ
Acting Secretary

SCIENCE AT THE SODA FOUNTAIN

ROBERT H. CARLETON
Executive Secretary, National Science Teachers Association, Washington, D. C.

One of the soda fountain girls was rubbing half a lemon over the surface of a sandwich grill. I inquired, "Why are you doing that?"

"Keep quiet," she said, "Do you want me to get fired?"

"I don't get it. Why would you get fired for doing that?"

"Well," she said, "its so hard to clean the grease off this grill I use lye to cut the grease, and then I use lemon to kill the lye. And the manager don't know about it."

I thought, "That's pretty good applied chemistry even though she doesn't know how to write and balance equations for what she's doing."

That was the first "science episode" that happened at the soda fountain in the corner drug store there in Summit, New Jersey, where I was teaching chemistry and physics in the high school. The second one went like this.

Customer: "Gimme a quart of coffee to go. Put it in this Mason jar."

Soda fountain girl: "Okay; give it here."

She places a silver (?) knife in the jar and then pours in the hot coffee.

Me: "Why the knife in the jar?"

She: "That's to keep it from breaking from the hot coffee."

Me: "I don't get it. How does it work?"

She: "The heat goes into the knife instead of the glass. Then the glass won't break or crack from the heat."

Me: "Where did you learn that?"

She: "I don't know. I always do it that way. Maybe I learned it from my mother. She always puts a silver spoon in the glasses when she makes jelly."

Me: "Well, does it work?"

She: "Oh, sure. 'Course, sometimes the glass breaks anyway, but most of the time it works."

Me: "How does the heat know enough to go into the knife instead of into the glass?"

She: "Don't ask me. Besides, I can't talk to you all day; I gotta take care of my customers."

And that was that. Except that we had a heated (what a pun!) discussion about it in our physics classes the next day.

UNIVERSITY OF MICHIGAN LIBRARIES

Don't pass up any opportunity to add life and interest to what is studied in class. Take an inventory of the science to be found at *your* soda fountain and let your students work out the story of how the things they have learned are applied. Here are a few examples.

1. The vacuum coffee-maker. What forces the hot water from the lower to the upper portion? What "pulls" the water back down again?
2. What is the horsepower of the electric motor used to mix a malted milk?
3. How is Henry's law helpful in making ice cream sodas?
4. What is the over-all mechanical advantage of an ice cream dipper?
5. What are the Board of Health regulations for employees who work at soda fountains and food counters? How often must they have examinations, if any?
6. How does the store's air-conditioning system work?
7. How does the Board of Health check on the cleanliness of the eating utensils used at the food counter? (Perhaps the class can make some checks of their own.)
8. What are the wattage and amperage of the electric grill?

There are, of course, other opportunities than the soda fountain to study applied science. How about the science to be found at the corner gasoline station? Is there any applied science at work in a grocery store? Or a "home-made candy" shop? Give the students a hint and a green light. They'll uncover many such locations of everyday science at work.

A NEW GEOGRAPHY OF RUSSIA

"In what form is uranium found in Russia? How important is the Moslem minority in the U.S.S.R.? How much have Americans contributed to discoveries in the Russian Arctic? What is the extent of the permanently frozen ground in Russia?"

The answers to these and many other pertinent questions about the people and land of the U.S.S.R. are found in a new book, "Geography of Russia," written by N. T. Mirov and published in February by John Wiley & Sons.

Written specifically for the American reader by a Russian-born and -educated author, this book first presents a general view of Russia's more than 8½ million square miles, and then describes the topography, glaciation, climate, rivers, and mountains of the various regions. Pointing out that many subtle undercurrents in Russian life escape the stranger, Dr. Mirov discusses the country's languages, races, and religions, in addition to providing explanation for many Russian geographical expressions.

In the current world situation, Americans have become concerned with the peripheral regions of Russia, especially those near North America. Drawing on his own scientific explorations of the Pacific coast of Siberia from the Korean border to the Bering Sea, Dr. Mirov offers a detailed description of these peripheral regions, including the islands near the coast of Siberia and the peninsula of Kamchatka.

Currently a lecturer in geography at the University of California, Dr. Mirov is a plant physiologist in the Genetics Division of the California Research Station of the U. S. Forestry Service. During World War II, he taught Russian geography to military men and foreign correspondents.

Rough-service electric bulb, for use with extension cords in shops and in many other applications, is smaller and sturdier than its predecessor but provides more light. It is a 100-watt affair, developed for use in portable equipment and is made with either clear or inside frosted glass.